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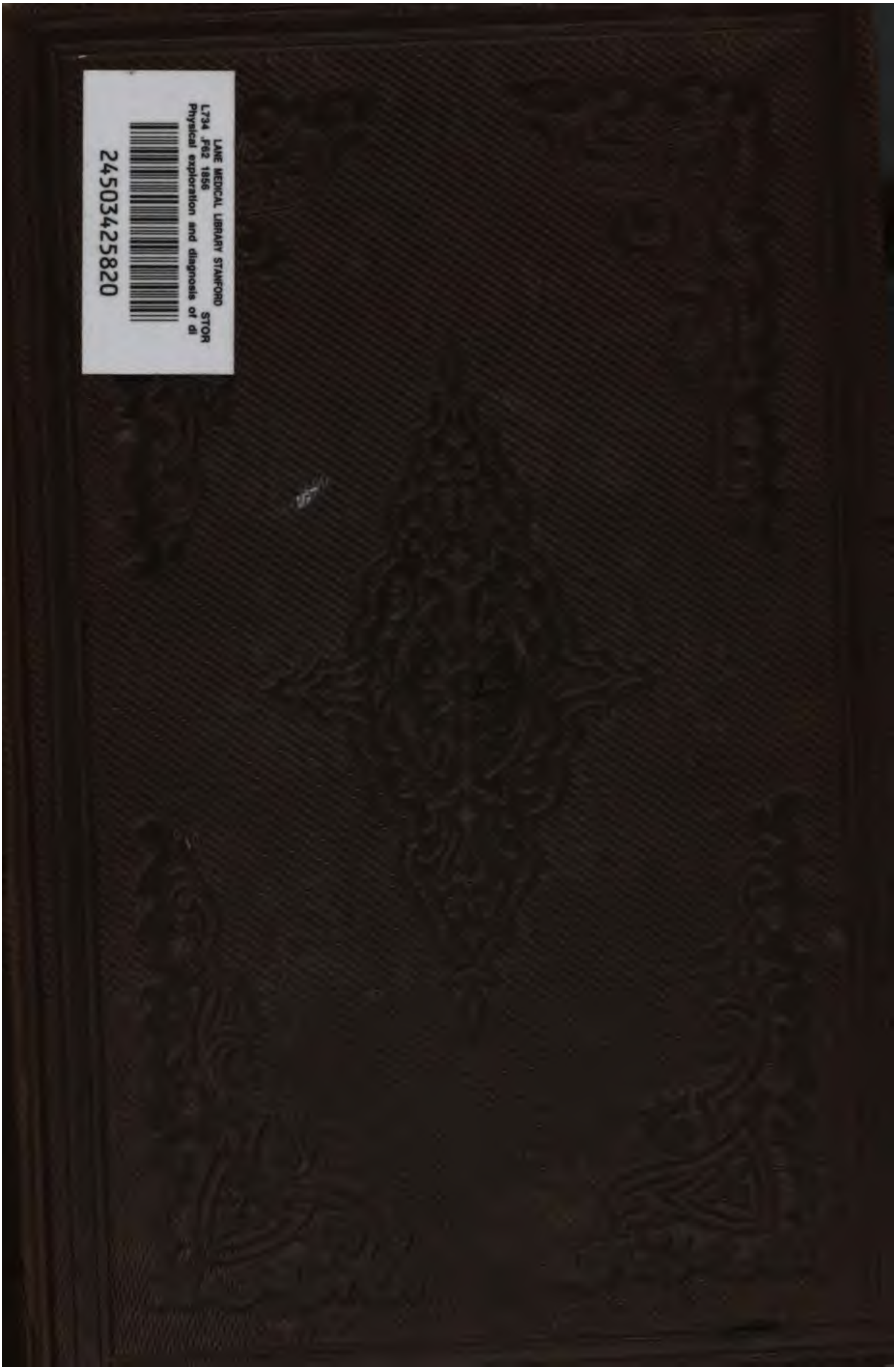

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PHYSICAL EXPLORATION

AND

DIAGNOSIS OF DISEASES

AFFECTING THE

RESPIRATORY ORGANS.

BY

AUSTIN FLINT, M.D.,

PROFESSOR OF THE THEORY AND PRACTICE OF MEDICINE IN THE UNIVERSITY OF LOUISVILLE;
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TO

PROFESSORS CHARLES B. COVENTRY, CHARLES A. LEE,
JAMES P. WHITE, FRANK H. HAMILTON,
GEORGE HADLEY, BENJAMIN R. PALMER, JOHN C. DALTON, JR.,
AND EDWARD M. MOORE,

WITH WHOM THE AUTHOR WAS FORMERLY ASSOCIATED
IN THE
University of Buffalo,
AND
TO HIS MEDICAL FRIENDS IN THE CITY OF BUFFALO,
THIS VOLUME
IS RESPECTFULLY DEDICATED.

PREFACE.

THE great importance of physical exploration in cases of thoracic disease is now generally admitted. While its scope of application, the significance of certain of its phenomena, and more especially the mode of their production, furnish occasions for discussion and differences of opinion, few intelligent physicians, at the present day, refuse to acknowledge that the discovery of Laennec forms a memorable epoch in the history of medicine; nor will the claims of this branch of our art on the attention of the medical practitioner be denied by any who are qualified to place a proper estimate upon its value. But although these positions are indisputable, the number who give much attention to the principles and practice of physical exploration is quite small, its advantages being practically rejected by a large proportion of the medical profession. May not this be in a measure due to the paucity of works treating of the subject specially, and with a degree of fulness commensurate with its importance? This inquiry, mainly, has led to the preparation of this volume. The founder of auscultation succeeded in bringing the diagnosis of diseases affecting the pulmonary organs to an astonishing degree of precision. Yet the labors of those who have followed in the footsteps of their illustrious master, have done much for the improvement and extension of physical exploration; so that the great work of Laennec, remaining as it ever will a splendid monument of his genius and industry, is no longer adequate to a complete exposition of our existing knowledge. The few special treatises which have more recently appeared, are mostly designed as manuals for the medical student. The most comprehensive work published in our language within late years is the admirable treatise by Prof. Walshe. In this work, which includes diseases of the heart and aorta, embracing also the morbid anatomy and treatment, as well as the diagnosis, the consideration of physical signs is necessarily condensed. My aim has been to supply what appears to me a desideratum, viz., a work limited to diseases affecting the respiratory organs, treating *in extenso*, and almost exclusively, of the principles and practice of physical exploration as applied to the diagnosis of these affections. So much, briefly, for the motives and objects which have prompted the undertaking.

In preparing the volume now submitted to the profession, my plan has been to treat of the physical signs as regards their individual and differential characters, their significance and diagnostic relations, separately and combined, without imposing on myself restraint on the score of brevity. Whilst I have desired not to be either tediously minute or diffuse, I have intentionally amplified, somewhat after the usual mode of oral teaching, under the belief that this course would best subserve the interests of the reader, and that the importance of the subject renders no apology necessary for the size of the book.

I have striven to make the work as practical as possible; and, therefore, the various topics are considered with almost exclusive reference to their direct clinical bearings. Very little attention is devoted to theoretical questions. To the mechanism of physical phenomena relatively small space is accorded, recognizing as the only safe basis of our knowledge of their significance and pathological relations, clinical facts taken in connection with morbid anatomy, and believing that *à priori* deductions from the laws of physics, or analogical inferences from experiments made out of the body, and even with the dead subject, are to be received with great circumspection. The recapitulation in different pathological connections of the distinctive characters of the different signs, which, as the reader will notice, is a feature of the work, has not arisen from inadvertency; for, whereas, perfect familiarity with these characters is indispensable to skill or success in the practice of exploration, they are to be fixed in the memory by means of repetition, on the principle which underlies the oral system of acquiring a foreign tongue. The motto, "*répétition sans cesse*," adopted by an author of French exercises constructed after this system,[1] is well suited for the student or practitioner who is ambitious to excel in physical exploration.

Whoever undertakes to write a didactic treatise, in effect, assumes that he is competent to the task. It is not, therefore, unbecoming for me to state that during several years devoted to clinical pursuits, the physical exploration of the chest has occupied a considerable share of my attention. Of most of the practical points embraced in this work, I am able to speak from experience. With respect to certain signs, the views which I have been led to form from personal observation are original. I may particularize here, the characters of pitch distinguishing the respiratory sound commonly called *rude* or rough, and which give to a prolonged expiration its significance as a sign of increased density of lung from tuberculous or other solid deposit; also, the relative pitch of the inspiratory and expiratory sounds in the cavernous, as contrasted with the bronchial, respiration. Other points, not dwelt upon by writers on this subject, which I may mention in this place, are the importance of determining the line of the interlobar fissure, as a means of distinguishing between the percussion-dulness of lobar pneumonitis and liquid effusion, and the clinical value of the *souffle* or bellows' sound, accompanying the act of whispering, as a sign of solidification. In the perusal of the work, the reader will perceive that occasionally the results of my own observation do not altogether accord with the opinions of others. Under these circumstances, I do not hesitate to follow a rule which, as it seems to me, in matters purely of observation, should not lead to the imputation either of egotism or presumption, viz., not to be more ready to distrust one's own accuracy than that of others. Were an opposite course to be required, there would be small encouragement for original research. While engaged in writing the work, I have been forcibly impressed with the need of farther analytical investigation of carefully recorded data. Questions have so frequently arisen which are to be settled only by an appeal to the results of observation, that I have sometimes been tempted to lay aside the pen, and have resumed it only under the conviction that such questions must, for a long period, continue to arise; and that to wait for the means of meeting promptly every inquiry, is equivalent to an indefinite postponement. This field of research, like every other in the extensive domain of medical science, offers scope for unlimited improvement; and it is to be expected that continued efforts in its cultivation will develope additional resources, rendering it more and more valuable.

---

[1] Manesca.

Endeavoring, as far as practicable, to exhibit the actual state of our present knowledge of the physical diagnosis of diseases of the respiratory organs, I have availed myself of the latest and most approved works on the subject. My acknowledgments are especially due to the Practical Treatise on the Diseases of the Lungs, Heart, and Aorta, by Professor Walshe, and to the Traité Pratique d'Auscultation, etc., by MM. Barth and Roger.[1] I have also consulted with advantage, the works of Stokes, Fournet, Gerhard, C. J. B. Williams, Hughes, Bowditch, Swett, Alfred Stillé, Holmes, J. Hughes Bennett, and Skoda. In addition, numerous papers on particular topics have been examined, as well as books treating incidentally of matters pertaining to physical exploration, which are referred to in the body of the work.

One of the authors just named has enunciated views, which, from their novelty and boldness, have attracted considerable attention. I refer to Professor Skoda, of Vienna. The theory of consonance, by which this author attempts to explain some of the most important of the physical signs, and upon which he bases certain practical conclusions, appears to me very far from being satisfactorily established. In his classification and designation of physical signs, I am unable to perceive that aught is gained in clearness or simplicity. Some of his assertions pertaining to matters of simple observation, involve a denial of the positive results of the experience not of one, but of nearly all observers—for example, that the crepitant rale, as described by Laennec, is rarely heard in pneumonitis, and that the percussion-resonance is not affected by the presence of isolated tubercles in a very considerable quantity, unless accompanied by an altered condition of the interstitial tissue. Moreover, the pervading tone of the work tends to create in the mind of the student a scepticism with respect to the value of physical exploration, which is at variance with the confidence of other observers not less experienced than himself. In venturing upon these critical remarks, I am alone actuated by a desire that the importance of the subject should not be undervalued. Frequent occasions for reference to the valuable contributions of Professor Skoda will appear in the following pages.

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[1] The editions of both these works for 1854, are referred to.

In order that physical exploration shall be available in the hands of practitioners who have neither time nor inclination to devote to it special attention, to the prejudice of attainments in other branches of medical knowledge, as much simplicity in its principles and practice as comports with a due regard to its usefulness, is to be desired. Needless distinctions and over refinements are to be deprecated. Mutations in classification and nomenclature are as much as possible to be avoided. With these views, I have refrained from suggesting additions or changes, which, should they even be considered improvements, might occasion complexity and confusion; and I have passed over some points which, from their dubious or unimportant character, seemed likely to prove a source of embarrassment, rather than an advantage to the student. The only innovations I have ventured to propose are the substitution of a new name for *rude* or *rough* respiration, viz., *broncho-vesicular*, and the use of the terms *vesiculo-tympanitic* resonance, applied to a percussion-sound combining the tympanitic and vesicular qualities, and *broncho-cavernous* respiration, denoting a mixture of the cavernous and bronchial modifications of the respiratory sound.

In conclusion, I embrace this opportunity to express acknowledgments to my friend, Professor Alfred Stillé, for kindly consenting to read the proofs of the work as it has passed through the press. While I have no right to hold him responsible for any of its defects, I am truly grateful to him for many valuable suggestions.

UNIVERSITY OF LOUISVILLE, KY.
February, 1856.

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PHYSICAL EXPLORATION.

INTRODUCTION.

SECTION I.

PRELIMINARY POINTS PERTAINING TO THE ANATOMY AND PHYSIOLOGY OF THE RESPIRATORY APPARATUS.

THE study of diseases affecting the respiratory apparatus involves, as a point of departure, acquaintance with the several structures, organs, and functions which this apparatus embraces. To this preparatory knowledge it is presumed, of course, the reader has already given more or less attention; but it will be useful to review certain points pertaining to the anatomy and physiology of this portion of the organism, which will be found to have direct and intimate pathological relations. To these points this section will be mainly limited, omitting details other than those of special importance in their bearings on the subjects to be subsequently considered.

The respiratory apparatus comprises 1st, the thoracic parietes, inclusive of the diaphragm; 2d, the pulmonary organs contained within the thoracic cavity; 3d, the canal or tube leading from the lungs to the pharynx, consisting of the bronchi and their subdivisions, the trachea, and larynx. The throat, mouth, and nasal passages, although involved in respiration, are rather adjuncts of the respiratory apparatus than constituents of it, their construction having more direct reference to other functions.

I. THE THORACIC PARIETES.

The portion of the skeleton called the thorax is composed of the dorsal vertebræ, the ribs, and the bones of the sternum, forming by their union, together with their intervening cartilages, a truncated cone, designed to protect the organs which it contains, and to be subservient to certain movements concerned in respiration. The bony arches, the ribs, exclusive of the two last on each side (reckoning, as is usual, from the summit of the cone downward), are joined, either to the sternum, or to each other, by cartilages to which the walls of the chest are in a great measure indebted for their elasticity and mobility. The superior seven ribs joined to the sternum are called the *true* ribs, and the remaining five on each side are distinguished as the *false* ribs. The two lowest on each side, from the fact that their anterior extremities are disconnected from those situated above them, as well as from each other, are known as the *floating* ribs. The elasticity of the costal cartilages is greatest in early life; it becomes impaired, as a general rule, in proportion to age, and with advanced years may be nearly lost in consequence of ossification. Under these circumstances the alternate increase and diminution of the thoracic capacity with the two acts of respiration, so far as the successive expansion and contraction of the thoracic walls are therein involved, must of necessity be in some measure restrained.

The direction of the first rib is nearly horizontal. The remainder have an oblique direction downward, the obliquity increasing with each inferior rib. Below the third rib the costal cartilages also have an oblique direction, but not corresponding to that of the ribs. From the point of their attachment to the ends of the ribs, they pursue an upward direction to their sternal connections. Hence a line coincident with the axis of these ribs, forms with a line passing through the axis of their cartilages, an angle which is more acute with each inferior rib. The length of the costal cartilages also increases successively with the three lowest of the true ribs. These anatomical points, viz., the oblique downward direction of the ribs, and the oblique upward direction of their cartilaginous prolongations, are provisions for the respiratory movements, so far as these movements relate to the anterior and lateral portions of the chest. With the act of inspiration, more especially when its force is voluntarily augmented, the lateral and antero-posterior diameters are increased. This is effected chiefly by the elevation of the ribs, by which their obliquity is diminished, causing them to approximate and even attain to a horizontal direction, tending thus to bring the ribs and the costal cartilages on a continuous line, diminishing or abolishing the acute angle formed by the union of the ribs and cartilages. After the cessation of the motive power which effects these changes, in other words, with the act of expiration, the elasticity of the cartilages suffices to restore that relation to the ribs which is naturally assumed. These movements are abnormally increased and diminished in consequence of different forms of disease. A change, also, as regards the oblique direction of the ribs is attendant on certain thoracic affections, viz., pleurisy with a large accumulation of liquid in the pleural sac; the presence of liquid and gas in pneumo-hydrothorax, and in some instances of abnormally distended lung, constituting a form of emphysema. In connection with these affections the same changes are mechanically produced which are effected by a forcible act of inspiration, with the important difference, that while the enlargement of the chest in the latter case is but for an instant, in the former case it persists so long as the morbid conditions which have induced it continue.

The margins of the ribs are not in contact, but separated, leaving what are termed the *intercostal spaces.* In consequence of the progressively increasing obliquity in the direction of the ribs the intercostal spaces are broader in front than behind. Under different morbid conditions these spaces are increased and diminished in width. The former is incident to the accumulation of a large quantity of liquid in the chest, the latter to contraction of the chest following the removal of this liquid by absorption or otherwise. In the female skeleton the upper ribs are more widely separated than in the male, and they possess also, relatively, a greater degree of mobility. This anatomical difference in the two sexes has relation to the greater part which the summit of the chest takes in the respiratory movements in the female.

The intercostal spaces when the thorax is invested with the soft parts, are filled with muscular substance, which constitute a portion of the active agents employed in carrying on the respiratory movements. These intervening muscular layers are depressed below the level of the ribs, causing furrows, which are called the *intercostal depressions.* In persons with small or moderate adipose deposit, these depressions are plainly indicated on the surface, being observable especially in front and laterally, at the lower part of the chest. They are everywhere visible, except in the portions covered by the scapula, in cases of great emaciation. A change as respects this anatomical point occurs in certain diseases, viz., when there is an accumulation of a large quantity of liquid; and sometimes when the chest is dilated by over-distended lung in emphysema. Under these circumstances, especially with the former condition, the intercostal depressions are abolished, and the intervening integument may even project beyond the level of the ribs when a very large quantity of liquid is contained in the pleural sac.

The scapula and clavicle, with the soft parts, give to the thorax a shape quite different from that which it presents divested of these appendages. Compared to a truncated cone, the base is now above. These superadded bones, certain muscles investing portions of the thoracic walls, and, in the female, the mammary gland, offer obstacles in the way of exploring the chest for the physical signs of disease which will be noticed hereafter in connection with the consideration of these signs.

The partition wall separating the chest from the abdomen is the tendino-muscular septum, the diaphragm, springing from the lumbar vertebræ, from the first to the fourth inclusive, and attached to the six inferior ribs. Examined from below it forms a vaulted or arched roof of the abdominal cavity, its upper surface having a corresponding convexity extending into the thoracic cavity on each side. The height to which this convexity rises in the two sides is not equal, being greater in the right than in the left side. In the former it rises as high as the fourth intercostal space; in the latter to a level with the fifth rib. Thus the right chest has a vertical diameter somewhat less than that of the left. Accumulation of liquid within the pleural sac, and dilatation of the lungs in some cases of emphysema, may cause, mechanically, depression of the diaphragmatic arch; and, on the other hand, enlargement of the liver on the right side, and, on the left side, enlargement of the spleen, or distension of the stomach, will produce an elevation above the normal height.

The contraction of the muscular structure entering into the composition of the diaphragm diminishes its vaulted form, depressing it to a plane, thereby enlarging the vertical diameter of the thoracic space. In this way it becomes the most important agent in the act of inspiration, resuming its convexity with the act of expiration. These movements are liable to be restrained, or arrested by various affections, which will be presently mentioned.

Considered as divided into lateral halves, the thoracic parietes on the two sides, not only as respects the skeleton, but when invested with the soft parts, should be nearly symmetrical, so that any considerable deviations in this point of view, denote either present disease, or deformity. An exception relates to the semicircular measurement at the middle and inferior portion of the chest. The right side usually, but by no means invariably, measures somewhat more than the left, the average difference being about half an inch. Of 133 cases of persons in good health in which measurements were made by M. Woillez, the right semi-circumference exceeded the left in 97; the left exceeded the right in 9, and both sides were equal in 27. The greater size of the right side, as determined by measurement, is usually attributed to the presence of the liver on that side. The facts presented by the author just named, however, seem to show that it depends, in a measure at least, on the greater use of the right upper extremity, which is habitual with most persons. In no instance in which the persons were *right-handed* did the left exceed the RIGHT SIDE in measurement; on the other hand, of cases in which the persons were *left-handed*, in three the left side exceeded the right, and in the remaining two cases both sides were equal. In a perfectly symmetrical chest the shoulders should be on the same level; and in the male, the nipples situated on the fourth rib, or the fourth intercostal space, should be on the same transverse line, and equidistant from the centre of the sternum. The general law of symmetry as regards correspondence in similar portions of the chest on the two sides, is of importance in determining the existence of intrathoracic diseases; and, with reference to its application, it is to be borne in mind that certain past affections are liable to leave deviations more or less permanent. The most common cause of deformity is spinal curvature, which may be sufficient to disturb the symmetry of the two sides without existing to a degree to be noticed unless a careful comparison be instituted. Cases of slight lateral curvature depressing the shoulder and nipple of one side (oftener the right than the left side), approximating the margins of the ribs, and diminishing the semi-circumference, are very frequent, and liable, without special attention, to be overlooked. Certain diseases within the chest lead to marked alterations in the conformation on one side. This is true especially, as will be seen hereafter, of chronic pleurisy. The chest on one or both sides may be deformed in various ways irrespective of spinal curvature. Thus the sternum may project unnaturally, causing the "chicken" or "pigeon breast," or on the contrary more or less depressed; there may be flattening on one side produced perhaps by pressure from the arm of the nurse in early infancy; contraction at the lower part of the chest in females, occasioned by tight lacing; distortions from fractures or other injuries, etc. These deviations from symmetry are sufficiently obvious, and will not therefore escape notice. Practically, they are of great importance in determining the physical signs of *present* disease. The greater portion of these signs, as will be seen hereafter, being based on the assumption that, irrespective of present disease, the two sides of the chest are in unison, it becomes obviously an essential preliminary to determine, in individual cases, to what extent the law of symmetry is applicable. The researches by M. Woillez[1] show that chests presenting in all particulars complete regularity of conformation are found in only the proportion of about twenty of every hundred persons. Deviations from symmetry, either disconnected from disease (physiological), or resulting from previous morbid conditions (pathological), therefore, exist to a greater or less extent, in a large proportion of individuals. This fact would impair very materially the value of physical exploration were it not practicable, as it generally is, to determine whether deviations which may be discovered are due to present disease, or existed previously.

The *respiratory movements* involve certain points important to be premised in addition to those already noticed.

A complete respiration, as is well known, comprises two acts, viz., an act of *inspiration*, and an act of *expiration*. In health, after adult age, the respirations are repeated from 14 to 20 times per minute, the habitual frequency varying considerably within healthy limits in different individuals. The frequency is somewhat greater in females than in males, and still greater in children. Deviations as regards the frequency of the respirations, exceeding the limits of health, are important symptoms of disease. In various affections compromising the function of hæmatosis, the frequency of the respirations is considerably increased, rising for example in bronchitis affecting the smaller tubes, to 30, 40, 50, 60, or even a still greater number, *per minute*. On the other hand, an abnormal diminution in frequency accompanies certain morbid conditions of the nervous system affecting indirectly the respiration. Thus, the respirations are morbidly infrequent, or slow, in apoplexy, and coma, however induced. The immediate object of the act of *inspiration* is the enlargement of the thoracic space, the air rushing in to fill the vacuum thus created within the air cells and tubes of the lungs. This enlargement is effected by means of muscles attached to the thoracic walls, on the one hand, and, on the other hand, by the depression of the diaphragm. The immediate object of *expiration* is to restore the chest to the dimensions it naturally assumes when not acted on by the dilating muscles, and to contract it sometimes beyond that point, thus causing expulsion of the air received by the act of inspiration. The simple restoration of the chest is due mainly to the elasticity of the dilated parts, but contraction beyond the dimensions which it naturally assumes, is effected by expiratory muscles. The movements incident to the two acts, respectively, in ordinary or tranquil respiration; the modifications exhibited when the breathing is exaggerated or forced; the normal differences to be observed in different persons; the variations due to age, sex, etc., are physiological points, not only interesting in themselves, but of utility in order to appreciate the aberrations associated with diseases of the respiratory apparatus. In bestowing some consideration on these points I shall not detain the reader with minute descriptions, still less engage in discussions relative to the mechanism of respiration, which, however much of interest they may possess for one desirous of investigating the subject fully, are not of special importance in view of pathological relations.

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[1] "Recherches pratiques sur l'inspection et la mensuration de la poitrine, considérées comme moyens diagnostiques complémentaires de la percussion et de l'auscultation." Paris, 1837. Archives Générales de Médecine, 3ème Série, tome i, p. 73.

In ordinary breathing, *in the male*, the diaphragm is usually the more important and indeed sometimes almost the sole efficient agent. The diaphragmatic movements are indicated by a perceptible rising and falling of the abdomen. But in certain diseases these movements are to a greater or less extent restrained, and they may even be completely arrested. They are notably diminished in acute peritonitis, being unconsciously repressed in consequence of the pain which they occasion; and they are mechanically prevented by a great quantity of liquid within the peritoneal sac, by enormous distension of the stomach or intestines with gas, and by abdominal tumors, inclusive of pregnancy. Under these circumstances the thoracic muscles take on a supplementary activity, which are rendered sufficiently obvious by the increased movements of the thoracic walls. The breathing is then said to be *thoracic* or *costal*. On the other hand, the movements of the ribs are voluntarily repressed in consequence of the pain incident thereto in acute pleurisy, or in pleurodynia, and they are mechanically limited by rigidity and ossification of the costal cartilages. The diaphragm, in this case, takes on an increased action. The breathing is then distinguished as *diaphragmatic* or *abdominal*, the latter term denoting the fact that this supplementary activity is manifested by a corresponding increase in the visible rising and falling of the abdominal walls. The deviations from normal respiration known as *thoracic* or *costal*, and *diaphragmatic* or *abdominal*, thus not only indicate the existence of disease, but point to its situation.

By certain intra-thoracic affections the movements of the chest are diminished, or suspended on one side, and, by way of compensation, abnormally increased on the other side. This obtains in cases of copious liquid effusion within one of the pleural sacs; and in some instances, of the affection called emphysema when limited to one lung. Paralysis of the muscles of a lateral half of the body (hemiplegia) may also be attended by diminished thoracic movements of the affected side.

Analysis of the movements of the thoracic walls developes other circumstances which are to be noted. The enlargement of the chest, exclusive of the diaphragm, in inspiration, is effected by the action of the thoracic muscles elevating the ribs, which, as has been seen, pursue an oblique direction, forming an angular connection with the costal cartilages. In proportion as the ribs are thus raised, the angles just referred to become less acute, and the ribs approach to a horizontal direction, the ribs and cartilages together approximating to a continuous line. At the same time the sternum is raised upward and projected forward. The ribs, also, are rotated backward at their spinal junction. The result is, the cavity of the chest becomes enlarged in every direction. Owing to the greater length of the lower *true* ribs as well as of their cartilages, and the greater acuteness of the angle formed by the union of the former with the latter, these elevation and expansion movements, *in the male*, are much more marked in the lower, than the upper part of the chest; and they are greater during the middle, than either at the beginning or the end of the inspiratory act. In ordinary breathing, the ribs at the summit of the male chest appear to have little or no part in the thoracic movements. Accurate measurement shows that they do not remain quiescent, but the motion is usually so slight as scarcely to be perceived. The movements are mainly confined to the lower part of the chest and the abdomen, and frequently appearing to be chiefly limited to the latter. This, it is to be borne in mind, is true of *ordinary* breathing in the *male* sex. In exaggerated or forced breathing, and in the female, the respiratory movements present important modifications. It will facilitate the description of these modifications to adopt a subdivision of the thoracic movements made by MM. Beau and Maissiat,[1] which I am satisfied from my own observations is founded in nature. From an examination of a large number of individuals these observers resolve normal differences of breathing in the two sexes, as denoted by obvious movements, into three kinds, or as styled by them, *types*. In many persons, as already stated, ordinary breathing is carried on almost exclusively by the diaphragm. In these persons the chief visible evidences of alternate enlargement and diminution of the thoracic space, with the two respiratory acts, consist in the rising and falling of the abdomen. This is called the *abdominal* type of respiration. In other persons, of the male sex, movements of the lower part of the chest, from the seventh rib, inclusive, are involved in a greater or less degree. The type, then, is called *inferior costal*. This type is very rarely, if ever, presented alone. It is associated with the abdominal. Both types, in other words, are represented frequently in the male sex, different persons differing considerably as respects the predominance of one or the other type. The third type is called *superior costal*, and, as the title signifies, is characterized by the respiratory movements, being especially manifest at the summit of the chest. This type, as will be seen presently, is peculiar to females. Now, a change in the type of respiration generally characterizes exaggerated or forced, as contrasted with ordinary, breathing. The abdominal type becomes less marked, and the *inferior costal* appears to take its place. This is demonstrated by the ingenious researches of Mr. John Hutchinson,[2] the correctness of which may be easily verified by an examination of the nude chest in a living male subject. The respiratory movements, examined when the respiration is tranquil, and, afterward, when voluntarily increased, present, in the first instance, an abdominal motion more or less marked, with or without a certain degree of inferior costal motion; and, in the second instance, the abdominal motion, instead of being increased, is diminished, while the inferior costal motion is notably increased, a superior costal motion being sometimes superadded. Mr. Hutchinson was led to think that, with this change, the diaphragmatic movements almost ceased. This, however, is not the fact, as shown conclusively by Dr. F. Sibson. The expansion of the inferior ribs, which is measurably due to the diaphragm, prevents the rising and falling of the abdominal walls from being apparent. Nevertheless, it takes place, as may be satisfactorily proved by percussing the lower part of the chest before and after a deep inspiration. The evidence of the depression of the diaphragm thus afforded, will appear in a subsequent section.

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[1] Recherches sur le mecanisme des mouvements respiratoires. Archives Générales de Médecine, Décembre, 1842.

[2] Medico-chirurgical Transactions, vol. xxix, 1846.

The intercostal spaces at the lower part of the chest are somewhat widened with the act of inspiration, and, conversely contracted with expiration. At the summit of the chest, however, the reverse of this is the case. The ribs approximate very slightly in inspiration, in consequence of each rib being raised slightly more than the one above it.

The intercostal depressions which are apparent at the inferior portion of the chest laterally and anteriorly, especially in thin persons, are most conspicuous in the act of inspiration, and are increased in proportion to the extent of the inspiratory movements. This is the rule, but, according to MM. Beau and Maissiat, exceptions are occasionally to be observed.

The respiratory movements in the adult female differ in a remarkable manner from those which have been described as belonging to the male sex. In the adult female the superior portion of the chest presents, in the act of inspiration, an expansion notably greater than in males, the movements of the inferior portion of the chest, and of the abdomen, being proportionably less prominent. The contrast in this respect between the two sexes is striking. "The adult male," to quote the language of Dr. Walshe, "seems to the eye to breathe with the abdomen and the lower ribs, from about the tenth to the sixth; the adult female, with the upper third of the chest alone." In other words, the breathing peculiar to females is the *superior costal* type, while in males it is associated with the *abdominal*, generally combined, more or less, with the *inferior costal* type. To observe this difference in the two sexes, it is only necessary that the attention be directed to the subject when in the presence of ladies; but it is especially conspicuous when the breathing is convulsively affected by strong mental emotions, or when these emotions are simulated in histrionic performances. Hypothetically, two reasons suggest themselves, and have been offered to account for these differences in the two sexes—differences which it is of importance should be borne in mind with reference to the study of diseases of the respiratory apparatus. One of these reasons is, that nature has in this way provided for the due performance of respiration during the period of gestation, when the diaphragmatic movements are mechanically *impeded*. Boerhaave and Haller, who had observed this point of difference (which appears to have been lost sight of by more modern writers up to a period quite recent), considered it in that light. This, however, is simply adducing a final cause. Another reason, more entitled to be called an explanation, is, that the movements of the diaphragm and lower part of the chest become permanently impaired in females by modes of dressing, involving compression of the inferior ribs; and, as a consequence, the superior thoracic movements are unnaturally developed. The validity of the latter explanation, it is evident, hinges on the question whether the differences be natural or acquired; and this question is to be decided by examining girls and adult females whose waists have not been encased in any restraining or contracting apparatus. With respect to this point the conclusions at which different observers have arrived, are not altogether uniform. Dr. Walshe states that he has examined a considerable number of female children, aged between four and ten years, who had never worn stays, or any substitute therefor, who presented, nevertheless, the predominant action at the summit of the chest, observable in adult females, the peculiarity, however, being less than in later years. He states, also, that the female agricultural laborer breathes more like a male than the town female; and that during sleep the difference between the sexes is less conspicuous. MM. Beau and Maissiat affirm that they have observed this peculiarity marked in young girls, and in females from the country who had never worn corsets. But, according to their researches, the peculiarity does not become apparent till the third year of life. Prior to the age just mentioned the type of breathing in female as in male children is usually *abdominal*. Mr. John Hutchinson, in his valuable paper already referred to, says he "examined 24 girls between the ages of 11 and 14 who did not wear any tight dress, and found in them the same peculiarity in ordinary breathing." Mr. Francis Sibson[1] attributes the peculiarity to modifications of the chest induced by tight lacing. He states that "the form of the chest and the respiratory movements do not differ perceptibly in girls and boys below the age of 10." Still, he remarks, "it is probable that in females, even if they wore no stays, the thoracic respiration would be relatively greater, and the diaphragmatic less, than in man." Judging from the foregoing statements, by those who, within the past few years, have made the respiratory movements the subject of extensive personal investigations, it would seem that, although a certain amount of influence may be attributable to dress, the difference which has been pointed out is not wholly derived from that source. A collection of an extended series of observations relative to this point is, however, still a desideratum.

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[1] On the movements of respiration in disease, and on the use of a chest-measurer. Med. Chir. Trans of Royal Med. and Chir. Society of London, vol. xxxi, 1848.

The respiratory movements are modified by *age*. This is owing mainly to the differences as regards the flexibility and elasticity of the costal cartilages which belong to different periods of life. In boys, the costal expansion is greater than adults, for the reason just stated; and in old men, when the cartilages become ossified, forming with the ribs one unyielding piece, the diaphragmatic movements are increased, and the costal proportionably diminished. Between the two extremes of life, the character of the respiration will be likely to approximate to that belonging to the one or the other, according to the proximity of the individual to boyhood or old age. In aged persons, whose costal cartilages are ossified, the action of the muscles elevating the ribs tells exclusively on their sternal ends; hence the motion of the sternum is marked, and owing to the greater length and obliquity of the inferior *true* ribs, the lower portion of the sternum is raised and projected more than the upper portion. An effect somewhat similar is produced in cases of permanent expansion of the chest from over-distended lung in certain cases of emphysema. The costal cartilages, although not rendered comparatively non-elastic by ossification, are kept on the stretch by the abnormally increased volume of the lung, and the ribs and sternum move upward in the act of inspiration "as if in one piece."

Infants present this modification: the abdominal movements are less, and the thoracic proportionably greater than in youth after the period of infancy is passed.

To determine with exactitude the amount of the alternate expansion and contraction of different parts of the chest with the two acts of respiration, some method of accurate measurement must, of course, be employed. An apparatus for this end has been devised by Dr. Sibson, which he calls the *chest-measurer*. It consists of several parts, as follows: 1, a brass plate, covered with silk, on which the patient lies; 2, an upright rod, divided into inches and tenths, to indicate the diameter of the chest; 3, a horizontal rod, moving by a slide on the upright rod, which can be lengthened by being drawn out like a telescope; 4, at the extremity of the latter a dial and rack. The rack, when raised by the moving walls of the chest, moves, by means of a pinion, the index on the dial. A revolution of the index indicates an inch of motion in the chest, and each division indicates the 100th of an inch.

By means of an instrument of this description the extent of motion of different parts of the chest may be ascertained with minute accuracy. It indicates, also, very correctly the relative duration of each of the two respiratory acts, and in the latter point of view is especially useful.

In the valuable paper already referred to, Dr. Sibson has given the results of a large number of observations on the movements of respiration in health and disease. The more important of these results, relating to healthy movements, are embraced in the following summary: In the healthy, robust male, the movement of the sternum, and of the ribs from the first to the seventh, is from ·02 to ·07 inches during an ordinary inspiration, and from ·5 or ·7 to 2 in. during a deep inspiration. The ordinary abdominal movement (diaphragmatic), is from ·25 to ·3 in.; the extreme from ·6 to ⅙ in. As regards the two sides of the chest compared, the expansion of the second ribs is alike on the two sides; but below, the inspiratory movements, both in ordinary and forced breathing, are somewhat less on the left than on the right side, especially over the heart. In females, when stays are on, the thoracic movement at the second ribs, is from ·06 to ·2 in.; the abdominal, from ·06 to ·11 in. When the stays are off, the thoracic movement is from ·03 to ·1 in., and the abdominal from ·08 to ·2 in. The latter observations, as Dr. S. remarks, render it certain that the wearing of stays materially influences the respiratory movements, lessening the movement of the diaphragmatic ribs, and exaggerating that of the thoracic. They do not, however, disprove the fact that a natural difference exists in the two sexes, which other observations appear to establish. The reader, desirous of farther details, will find them in the paper from which the above summary is taken.

The *chest-measurer* of Dr. Sibson, and other contrivances to determine the amount of motion with the same exactness, have the disadvantage of being more or less complicated and cumbersome. A simple graduated tape will suffice to determine, with tolerable accuracy, differences of size, both lateral and antero-posterior, between a full inspiration and a forced expiration. But to ascertain by this mode the precise degree of motion in ordinary breathing is very difficult, the results varying very considerably according to the degree of tension with which the tape is held. This difficulty will be at once apparent to any one who attempts to employ this more simple instrument for that end. The results are only remote approximations to accuracy. Dr. Quain has endeavored to obviate the difficulty attending the use of the simple tape, without impairing much its simplicity, in the instrument contrived by him, which he calls a *stethometer.* It consists of a cord connected by an axle with an index which it is capable of moving over a graduated dial. The cord being extended from a fixed point on the chest to another, the extent of the respiratory movement will be manifested by the tension made on the cord being communicated to the index, and shown in figures on the dial, from which it can be read off in fractions of an inch.[1]

Practically, however, it is not of much importance to determine with mathematical accuracy the extent of the thoracic and abdominal movements with reference to the phenomena of disease. The eye will answer for an estimation somewhat rough, but sufficiently exact for clinical purposes.

Intra-thoracic disease may be evidenced by marked diminution of the movement of a portion of the chest. This is often observed in tuberculosis of the lungs, at the superior part of the chest on one side; oftener in females than in males, in consequence of the greater mobility in them naturally in that situation. Local emphysema of the lungs may also produce a similar effect, accompanied by an abnormal protrusion or bulging of a portion of the chest.

The respiratory movements, as has been seen, are abnormally increased in pregnancy, and in various affections which compromise the function of hæmatosis. When this increase is but moderate, it is stated by MM. Beau and Maissiat that the movements in one individual will differ from those in another, according to the type of breathing natural to the individual. Thus, if the type be purely abdominal, the abdominal movements alone will be increased; but if it be inferior costal, as well as abdominal, the movements of the lower ribs will be conspicuous; and if, as in females, it be superior costal, the exaggeration will be found to affect chiefly the superior portion of the chest. In cases, however, in which the sense of the want of respiration, or dyspnœa, is intense, and the breathing exceedingly labored, the three types may be simultaneously represented. But, under these circumstances, the thoracic muscles more especially are brought into active requisition, and in order to effect the utmost possible enlargement of the chest, various muscles are employed which are capable indirectly of aiding in respiration. An erect or sitting posture, being most favorable for the action of these muscles, is also selected. These changes will claim attention in connection with the symptomatology of the diseases in which they are exemplified.

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[1] Coxeter's Catalogue of Surgical Instruments and Apparatus.

The rhythmical succession of the two acts of respiration, in other words the order of their alternation, relative duration, etc., and the degree of power belonging to each act, involve certain points of interest, which have also important relations to the study of diseases.

Of the two acts, *inspiration*, in ordinary breathing, is accomplished by the active exertion of muscular power. An ordinary *expiration* follows as a consequence of the suspension of the muscular force which has occasioned the preceding inspiration, being due chiefly to the weight of the abdominal organs, which, with the elasticity of the abdominal walls, press upward the diaphragm; together with the elasticity of the ribs, costal cartilages, and the contained pulmonary organs. It is only when the expiration is voluntarily increased or prolonged, or when it is spasmodically exerted, as in coughing or sneezing, that a notable degree of muscular power is exerted in this act. But the co-operation of the muscles with the several circumstances that have been mentioned, determined either by volition or spasmodic action, renders the act more forcible than that of inspiration. Mr. Hutchinson,[1] by a series of experiments, showing the force of the two acts, respectively, as indicated by the elevation of a column of mercury, arrived at the result, that the expiratory, with muscular co-operation, exceeds the inspiratory by one-third. This excess of force he thinks is about equal to the elasticity which is brought to bear on the former act. The greater power of expiration when aided by the will, is manifest in the application of this respiratory act to various uses, such as singing, coughing, playing on wind instruments, glass-blowing, etc.

From the facts which have been stated relative to ordinary breathing, it follows, that the expiratory movement commences at the instant the inspiratory ceases. The latter is merged into the former, with scarcely any appreciable interval between the two. So far as the expiratory movement is readily appreciable, it appears to be considerably shorter than the inspiratory, and an interval of some duration seems to elapse, after the completion of an expiratory act, before the next inspiration commences. This interval, however, is more apparent than real. After the expiratory movement ceases to be obvious, the pulmonary organs probably continue to contract, in a manner not readily appreciable, nearly if not quite to the recurrence of the act of inspiration, unless restrained by a voluntary effort. This is illustrated sometimes in cases of catarrh or mild bronchitis, in which a laryngeal *râle* accompanies the entire act of expiration, the lungs not being affected so as to cease to represent the amount of collapse which takes place in health. As indicated by the continuance of this *râle*, the expiratory movement is prolonged, almost, or even quite, to the subsequent act of inspiration. The latter part of this movement is due, not to primary contraction of the thoracic parietes, but to continued collapse of the lung, together with the pressure of the abdominal viscera. Dr. Walshe estimates the interval between the end of one expiration and the beginning of the next inspiration, at one-tenth of the period occupied by both acts. But if we were to be guided by the cessation of the *obvious* abdominal and thoracic movements, the interval would be considerably greater.

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[1] Op. cit.

Judging from a cursory examination, or from attention to one's own respiration, the act of expiration appears shorter in duration than that of inspiration. The two acts, however, as determined by the chest-measurer of Dr. Sibson, in ordinary respiration, are generally equal in duration. When a difference exists, the expiration is oftener prolonged. This is apt to be the case in the tranquil breathing of women and children. It characterizes also the respiration in old age. In hurried breathing, in females especially, the expiratory act becomes relatively lengthened.

Neither the inspiratory nor the expiratory act is performed with a uniform degree of rapidity. The inspiration is at first slow, becomes gradually quicker, and again is retarded toward its close. The expiratory act is performed more quickly at first, and during the latter part more slowly than the inspiratory. These facts will in a measure account for certain differences in character which distinguish the expiratory from the inspiratory sound, as determined by auscultation in health and disease.

Deviations from the natural rhythm of the respiratory movements will be found to furnish characteristics of some forms of disease. In cases of obstruction seated in the larynx, or other parts of the air-passages, the expiration is morbidly prolonged. In emphysema involving an abnormal dilatation of the air-cells, and diminished elasticity of the lungs, the expiration becomes obviously much longer than the inspiration. On the other hand, a shortened and quickened, or spasmodic inspiration, is a significant symptom of some affection of the nervous system, occurring in some cases of hysteria, and also under circumstances in which it is of a much more serious import, denoting a morbid condition of great gravity affecting that portion of the nervous centre (medulla oblongata) which presides over the involuntary acts of respiration. The writer has called attention to the importance of this change in the rhythm of respiration in cases of continued fever, which will be found to precede often, in that disease, the occurrence of sudden coma.[1]

Finally, the size of the chest is a point remaining to be noticed. This may be estimated by circular measurement with a graduated tape. Persons differ considerably in this particular. The limits of variation in 994 cases in which the circumference was ascertained by Mr. Hutchinson, were from 30 to 40½ inches. Dr. Walshe fixes the average size at about 33 inches; but the normal deviations being so great, it is of little practical utility to determine a standard by taking the mean of a series of examinations. This point, clinically, is not of much importance, especially as the researches of Mr. Hutchinson show that the breathing capacity of the lungs dependent on the movements of the chest, bears no constant proportion to its size. Formerly it was supposed that contracted dimensions of the chest gave rise to a predisposition to diseases of the respiratory apparatus, more especially tuberculosis of the lungs; but it is now pretty well ascertained that little or no tendency to that, or other forms of disease, is derived from this source. In determining variations in the size of the chest, either by measurement, or by the eye, with reference to the evidences which may be thereby afforded of the existence of disease, we do not take the dimensions of the entire chest as the standard, but institute a comparison of one side with the other. This being the case, the capacity of the thorax proper to the individual is a matter of minor importance.

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[1] Clinical Reports on Continued Fever, etc., 1852.

II. PULMONARY ORGANS.

The lungs are the light spongy bodies contained within the chest, in which are effected the blood-changes constituting the function of hæmatosis. These organs are double, consisting of the *right* and *left* lung, each occupying a lateral half of the cavity of the thorax. The lung on each side is provided with a distinct membranous envelope—the pleura—which, after furnishing a covering for the pulmonary surface, is reflected upon the thoracic wall, and forms a shut sac, presenting the same arrangement as the serous membranes in other situations. The two pleural sacs are in contact at the median line, forming, by their juxtaposition, the mediastinal partition, or septum, dividing the two sides of the chest. Joined directly beneath the sternum, they diverge to form the anterior mediastinum, which encloses the remnant of the thymus gland; approximating, and becoming united, they again separate, forming the middle mediastinum, which contains the pericardial membrane enclosing the heart; and by a third separation is formed the posterior mediastinum, through which pass the descending aorta, thoracic duct, etc. The portion of this membrane investing the lungs is called the *pulmonic* or *visceral* pleura; and that lining the walls of the chest, the *costal* or *parietal* pleura. A third portion, forming a covering for the floor of the thoracic cavity—the diaphragm—is called the *diaphragmatic* pleura. Between the free surfaces of the two former portions in each lateral half of the chest, is what is termed the *cavity* of the pleura—erroneously so called, inasmuch as the free surfaces being in contact, there does not exist, strictly speaking, a cavity. Between these surfaces, within the shut sac of the pleura, liquid effusion takes place in pleurisy, and hydro-thorax, accumulating, in some cases, to the amount of several pounds, compressing the lung into a small solid mass, and producing changes in the external conformation of the chest, which have been already noticed, viz., enlarging its size, pushing outward the intercostal spaces, elevating the ribs from their oblique towards a horizontal direction, widening the distance between them, and compromising more or less the mobility of the affected side.

The parietal or costal portion of the pleura is thicker than the visceral or pulmonary portion, and than that covering the diaphragm. The areolar tissue uniting the membrane to the parts which it invests, called the subserous areolar tissue, is more abundant and looser in the former situation, and, consequently, the serous membrane is more easily detached from the walls of the chest than from the surface of the lungs. This, probably, explains a fact pertaining to inflammation of the pleura, viz., that the inflammatory action is more intense, and the products of inflammation are found to be more abundant, on the costal, than on the pulmonary surface.

The lung on either side varies in size according to the quantity of air which it contains, and, of course, its volume is alternately increased and diminished with the successive acts of inspiration and expiration. Its form is conoidal, the base being downward. The portion in contact with the walls of the chest extends lower than the central portion, in consequence of the arched or vaulted form of the floor of the chest—the diaphragm. Between the sides of the arch or vault formed by the diaphragm and the thoracic walls, is a space deeper behind than in front, which receives the inferior shelving border of the lungs. Thus at the lower part of the chest, on each side, a margin of lung intervenes between the diaphragm and the walls of the chest, more especially in the act of expiration, when the convexity of the diaphragm is greatest.

Owing to the fact already stated that the vertical diameter of the right side of the chest is less than that of the left, the right lung is shorter than its fellow. Transversely, however, the diameter of the right lung exceeds that of the left. This accords with a fact already stated, viz., that the semi-circumference of the right side usually exceeds that of the left by about half an inch. But there is another reason for the latter disparity. The situation of the heart is such that a portion of this organ encroaches somewhat on the left thoracic cavity, at the expense of the lung on that side. An irregularly triangular space between the fourth costal cartilage and the sixth rib, is occupied by the heart, uncovered by the lung and in contact with the chest. Vertically, this space averages, in the adult, about two inches; and horizontally, from the centre of the sternum, it extends about two and a half inches to the left. Overlapped by the lung, the heart extends still farther into the thoracic space, viz., vertically, from the third to the sixth costal cartilages; and, transversely, nearly to the nipple. In consequence of its lesser transverse diameter, together with the encroachment of the heart, the left lung is smaller in volume, notwithstanding, measured in a perpendicular direction, it is longer than the right lung. The right lung exceeds the left in weight as well as in volume.

When free from disease, or the effects of disease, the lung is devoid of any direct connection with the surrounding parts, excepting the point at which it is connected with the bronchia, the blood-vessels, lymphatics, and nerves which enter it to communicate, severally, with corresponding structures forming portions of the pulmonary organs. United by areolar tissue, including lymphatic glands, and enclosed in a sheath formed by a reflection of the pleura, the parts just enumerated compose what is termed the *root* of the lung. By the *root*, thus constituted, the lung, on each side, is, as it were, suspended or fixed, within the chest, the surface of the remainder of the organ being entirely free, in health, or adherent, to a greater or less extent (as is very frequently the fact), in consequence of morbid attachments. In its situation, the root of the lung is about equidistant between the base and apex.

The upper extremity of the lung, or apex, extends above the cavity of the chest, forming a blunted point, rising an inch and a half higher than the first rib. The latter fact is involved in the determination of tuberculous disease, or phthisis, in its incipient stage; that affection generally attacking, primarily, the superior extremity of the lung on one side.

The division of the lungs into *lobes* is a point of considerable importance in the study of certain pulmonary diseases. It is made by deep fissures extending in an oblique direction from above downward. The left lung presents a single fissure; the right has one fissure extending, like that of the left lung, around the whole circumference of the organ, and a second running from the anterior border a short distance only upward and backward. Thus divided, the left lung is said to consist of two lobes called the upper and lower; and the right lung of three, called the upper, lower, and middle lobes. The middle lobe of the right lung, however, is hardly entitled to be ranked as a separate lobe, but is "an angular piece separated from the anterior and lower part of the upper lobe." It is of importance with reference to the diseases, which are to be subsequently considered, to note the situation of the fissures dividing the lungs into lobes, as indicated by corresponding imaginary lines on the exterior surface of the chest. Posteriorly, they commence about three inches below the apex of the lung. Indicated on the chest, the line corresponding to their direction takes its departure at a point not far from the vertebral extremity of the spinous ridge of the scapula. On the left side the boundary line between the two lobes passes from the point just named obliquely downward to the intercostal space, between the fifth and sixth ribs, the anterior point of division falling a little to the right of a vertical line passing through the nipple. On the right side, the line marking the upper border of the lower lobe, passes obliquely downward to the space between the fifth and sixth costal cartilages. The line dividing the middle and upper lobes passes from the fourth cartilage in a direction upward and outward, for a distance varying considerably in different individuals. It follows from these statements that a small strip only of the lower lobe on each side is contained in the anterior portion of the chest, the greater portion being situated posteriorly. The physical signs, therefore, of morbid changes in the condition of the lower lobe are presented mainly in the middle and lower portions of the chest behind. It is very necessary to bear this in mind in examinations with reference to inflammation of the lung (pneumonitis), which, as will be seen hereafter, in a large proportion of cases, in the adult, is limited to the lower lobe. Inattention to this point may lead the medical practitioner to overlook that disease, limiting his examination to the anterior portion of the chest in cases in which the evidences of its existence are sufficiently apparent posteriorly.

The interlobar fissure, according to Rokitansky, becomes changed in its direction by the affection called emphysema seated in the upper lobe, tending under these circumstances to a vertical line.

The foregoing are the more important of the circumstances pertaining to the situation of the lungs, and the relations of their several parts, which claim notice from their pathological bearings. But an analysis of the anatomical structure of these organs will develope numerous points which are to be taken into account in studying their diseases.

In addition to bloodvessels, nerves, and lymphatics, which are common to most of the important organs of the body, the lungs are composed of the divisions and subdivisions of the *bronchiæ* or the bronchial tubes, and the air-cells or vesicles. These, combined, give to the lungs their distinctive traits of structure. The *bronchi*, after penetrating the lung, divide and subdivide in all directions, the divisions generally being of the kind called *dichotomous*, i. e. consisting of two branches, the mode of division most favorable for the speedy transmission of air. As the branches increase in number, they diminish in size, until, at length, they become extremely minute, and, finally, the ultimate ramifications, the capillary bronchial tubes, terminate in the vesicles or cells. The structure of the bronchial tubes, which are found to present in different situations important anatomical differences in addition to their gradations in size, and of the air-cells, the relations of the latter to the former, etc., must be understood before the student is prepared to enter on the study of diseases affecting the respiratory apparatus.

But prior to directing attention to points pertaining to the structure of these constituents of the lung, the *pulmonary lobules* should be described. What are ordinarily called the lobules of the lungs, are small portions of pulmonary substance, irregular in shape, united together, and, at the same time, isolated by means of intervening areolar tissue. The latter forms what is termed the *interlobular septa.*

If the surface of the lung be closely examined, it is found to present a great number of polygonal figures, indicated by dark lines. These lines, most marked in the adult, are the boundaries of the lobules, and the dark color is owing to pigmentary matter deposited in the interlobular areolar tissue. These lobulated divisions are very irregular both in form and size. As regards the latter, they vary from a quarter of an inch, to an inch in diameter (Kölliker). Different lobules, although in juxtaposition, have not, as already stated, any direct communication with each other. This is demonstrated by the following experiment. If a blowpipe be introduced beneath the pleural covering of the lung, and the subserous areolar tissue inflated, the air is forced into the interlobular partitions, the areolar tissue in the two situations being continuous. The lobules are thus surrounded by air, and rendered more conspicuous, but none gains admission into the cells or vesicles entering into the composition of the lobules. By careful dissection of lungs taken from a young subject, and especially from the fœtus, the different lobules may be separated from each other. They are then found to be quite distinct, being connected only by the minute bronchial tubes, called the *lobular bronchial tubes*, together with bloodvessels, nerves, and lymphatics. The different lobules of a lobe, thus separated, but attached to the branches of the *bronchiæ*, are likened by Cruveilhier to grapes attached to their footstalks and hanging from a common stem. Each lobule represents, in fact, a lung in miniature; the several lobes being made up of an aggregation of these diminutive lungs. Considered individually, each lobule is composed of the minute terminal branches of the lobular bronchial tube, which are sometimes called the *bronchioles*, in other words the capillary bronchial tubes, the air-cells, the vessels, and nerves,—these several anatomical constituents being supported and united by areolar tissue.

This subdivision of the lobes into lobules is exemplified in a form of pneumonitis (inflammation of the lungs) peculiar to children, called *lobular*, in distinction from *lobar* pneumonitis. In this variety, lobules in different parts of both lungs are attacked separately, the disease being in this way disseminated more or less. Collapse of lobules, in greater or less numbers, may also occur as a consequence of obstruction of their lobular bronchial tubes, of a nature permitting the egress of air from the cells with expiration, and preventing its ingress with inspiration. Owing to feebleness, or other causes, it has been ascertained that in newly born children certain lobules may not undergo expansion, retaining their fœtal, collapsed state. This has received the name of *atelectasis*, or imperfect expansion of the lungs. The embarrassment of respiration occurring at, or soon after birth, which may proceed to a fatal issue, is not unfrequently, there is reason to suppose, due to this condition.

In this connection it may be remarked that the pulmonary lobules are not equally permeable to air. Those most permeable are situated at the apex of the lung. This difference is due to the distribution of the larger bronchial tubes. According to Cruveilhier,[1] "a moderate inflation of the lungs, made as much as possible within the limits of an ordinary respiration, does not perhaps dilate one-third of the pulmonary lobules." Thus, "there are some lobules which are kept in reserve, as it were, and only act in forced inspiration." These interesting points will be found to be involved in the phenomena of disease.

The areolar tissue forming the interlobular septa is the seat of the very rare form of emphysema of the lungs called interlobular emphysema, in which air obtains access, by rupture between the lobules, widening the intervening spaces, and causing a projection of the septa above the pulmonary surface. A collection of air is also occasionally found after death, limited to a circumscribed space, within the areolar tissue connecting the pulmonic pleura to the surface of the lung, elevating the membrane in the form of a bleb. This is another form of emphysema. The form of that affection, however, which exists in the vast majority of cases, consists in

[1] Anatomy.

enlargement of the air-cells, or vesicles, either by coalescence or dilatation.

It remains to notice certain points pertaining to the structure, arrangement, and mutual relations of the bronchial tubes, and air-cells.

The general course and distribution of the bronchial tubes in the several lobes have been already described. The branches, successively and severally, end in double divisions, and with this rapid multiplication in number there is a corresponding diminution in size, down to the minute lobular bronchial tubes, which, after penetrating the lobules, subdivide into the terminal branches,—the bronchioles, or bronchial capillaries.[1] In referring to different sets of the bronchial tubes as the seats of disease, or of physical signs, it is customary to consider them as embraced in three classes, viz., the larger, the smaller, and the capillary tubes. In designating the site of morbid appearances after death it is sometimes convenient to indicate the divisions as those of the first, second, third, and fourth diameters: that is, the series of double branches are thus enumerated in the order in which they are given off. These are the larger bronchial tubes, the smaller being the subsequent series, inclusive of those passing to the lobules.

The larger bronchial tubes are composed of a fibrous membrane, containing irregularly shaped cartilaginous plates, the latter taking the place of the incomplete rings of cartilage which characterize the air-tubes exterior to the lung. These cartilaginous plates are situated especially at the bronchial divisions. They embrace, also, a layer of circular muscular fibres, of the kind called smooth or unstriped, belonging to the muscular system of organic, as distinguished from animal, life. This anatomical element is the seat of the affection known as asthma, and is sometimes involved in certain symptoms incidental to inflammation and irritation of the bronchial tubes.

They are lined by mucous membrane, covered with a layer of ciliated, cylindrical, or columnar epithelium, the object of the latter being, manifestly, to propel, and thus assist in the removal, by expectoration, of the secretions furnished by the mucous follicles in health and disease, as well as various morbid products formed within or poured into the tubes. This membrane is the seat of inflammation in ordinary bronchitis, and of irritation in pulmonary catarrh.

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[1] Called by Mr. Rainey, the "intercellular passages." (Trans. Royal Med. and Chir. Society, 1845.)

The smaller bronchial tubes present marked changes. The fibrous membrane, forming their basis, becomes thinner and thinner as the tubes diminish in size; the cartilaginous plates are less and less numerous; the mucous membrane is more and more attenuated, and, at length, when the calibre of the tubes is reduced to about a twentieth of an inch, the cartilaginous plates have disappeared, and the mucous and fibrous layers appear to have coalesced, forming a single thin membrane. The inner surface, however, still presents ciliated epithelium.

Finally, ramifying within the lobules, the ultimate bronchia terminating in the air-cells, as respects size, are truly capillary, having a diameter varying from one-fifteenth to one-thirtieth of an inch. These capillary tubes present still more important changes in structure. The membrane constituting their walls is exceedingly thin, and its inner surface does not present epithelium, cylindrical and ciliated, but it is that variety called indifferently squamous, tessellated, or pavement epithelium. The pulmonary capillaries, in fact, lose the characters which belong to the bronchial tubes, and assume the structure of the air-cells, with which they are immediately connected.

The anatomical changes which thus characterize different divisions of the bronchial tubes, are in accordance with certain striking facts pertaining to diseases of the respiratory apparatus. A principle of conservatism is often evidenced in the history of diseases by their reluctance, so to speak, to pass from one part to another part continuous, or contiguous, but presenting differences of structure. The latter appear to constitute the restraining barrier. This principle is exemplified in the fact that ordinary bronchitis is limited to the larger bronchial tubes, rarely extending to the smaller, to constitute what is incorrectly styled *capillary bronchitis.* The latter variety of the disease, as will be seen hereafter, is vastly more severe and dangerous.

Conversely, an inflammation seated in the air-cells and capillary tubes (pneumonitis), is usually limited to these parts, not extending to the branches of the *bronchia*, which, although in direct communication, are protected by differences in structure.

The air-cells, or vesicles, are the minute cavities in which the bronchial tubes are said to terminate. Their diameter varies from

$\frac{1}{200}$ to $\frac{1}{70}$ of an inch. After birth they are never free from air, and their size will depend on their degree of distension, this being, of course, considerably greater after an act of inspiration than after expiration. They are attached to the extremities, and also along the sides of the terminal branches of the bronchioles, or capillary bronchial tubes, with which they communicate by free openings. Microscopical observers have differed as to the existence of direct lateral communications between the cells. According to the best authorities, they do not communicate with each other, except indirectly, through the bronchioles, or capillary bronchial tubes. Their connection, however, with the latter is such that, although not direct, the communication is free.

A single bronchiole or terminal branch with its attached cells may be considered to form a common space, subdivided into numerous sections or *alveoli*. It is stated that the air-cells are larger toward the surface of the lung, and also toward the edges, than in the interior. Their size increases with age, and they are smaller in females than in males. Their walls possess much strength, shown by their not being easily ruptured by artificial inflation.

The air-cells are surrounded by yellow elastic fibres, which give to the lungs a considerable degree of elasticity. This is shown by the fact that they collapse, in a marked degree, when the cavity of the chest is opened.

It is within the cells that the atmospheric air received by inspiration exerts its effects on the blood. The pulmonary artery entering the lobes in company with the bronchi, divides and subdivides, without anastomosing, its branches accompanying the air-tubes, until it ends in a very fine capillary network ramifying on the walls of the cells. Here, also, commence the various radicles and branches, which, pursuing a retrograde course, like that of the arteries, collect the oxygenated blood and convey it to the left auricle. The blood within the capillary meshes surrounding the cells is brought into sufficient proximity to the air contained in the latter, for that interchange of principles to take place, by endosmosis and exosmosis, which is concerned in hæmatosis.

The air-cells and capillary tubes, together with the bloodvessels, nerves, and lymphatics, united by areolar tissue, constitute the pulmonary parenchyma, or the substance of the lungs. The cells and capillary tubes are the parts affected by inflammation in pneumonitis. Abnormal distension of the cells and capillary tubes, with or without atrophy and consequent destruction of more or less of the walls, giving rise to coalescence, constitutes the lesion in emphysema of the lungs. in the form in which it usually occurs.

It will be seen hereafter that some of the most important of the physical, signs of diseases within the chest have relation to anatomical points which the foregoing description has embraced.

With the enlargement of the chest in inspiration the lungs are dilated, by the pressure of the atmosphere filling the bronchial tubes and air-cells. The expansion of the lungs is attended by a certain amount of movement of the two pleural surfaces (the pulmonic and costal) remaining in contact, upon each other. This takes place especially at the inferior portion of the chest. As a provision against any injurious effects of the friction incident to this movement, which must involve a considerable degree of force, the free surfaces of the pleura are remarkably smooth, polished, and kept moist by the presence of a small quantity of liquid. Hence the two portions of the membrane glide over each other with the two acts of inspiration, not only without injury, but noiselessly. But it is otherwise in some cases, in which these surfaces are rendered rough or irregular by morbid products. The gliding movements are, under these circumstances, accompanied by friction sounds, which become the signs of disease. These sounds, as might be expected, are most likely to be produced where the movements of the thorax and the gliding of the pleural surfaces are greatest, viz., at the lower portion of the chest.

The movements upon each other of the pleural surfaces must be limited by morbid adhesions, more or less extensive, of these surfaces, which are found to exist in the larger proportion of bodies examined after death; and in certain cases, in which the costal and pulmonic pleuræ are universally adherent in consequence of general pleurisy, they must, of course, be entirely arrested. The latter condition it might be presumed would interfere with the expansion of the chest. Observations, however, show that this is not the fact. Mr. Hutchinson has given an account of a case in which there was not a square inch of the pleural surfaces, on one side of the chest, that was not firmly united; nevertheless in this case the expansion of the chest was in no degree diminished.

The quantity of air contained within the lungs not only varies greatly in different persons, but in the same person is constantly fluctuating within certain limits. It is difficult to determine these limits with exactitude, but in its pathological bearings this is not a matter of importance. The quantity after an inspiration is of course greater than that after an expiration, just in proportion as the amplitude of the chest is increased by the former, and diminished by the latter of these acts (*vide suprà*). Owing to the control which the will can exert over the breathing movements, much will depend on the influence of volition. Mr. John Hutchinson, in a paper to which reference has already been made more than once, has given the results of a large number of experiments to determine the quantity of air expelled from the lungs by a forcible act of expiration succeeding the fullest possible inspiration. This he considers a test of what he terms the *vital capacity* of the lungs. By means of an instrument called the *spirometer*, the quantity of air which a person is able to receive into and expel from the lungs is ascertained. The results of these experiments it is evident do not enable us to determine the quantity of air received and expelled in habitual respiration, in other words, the ordinary breathing capacity of the lungs. Nor do they assist us in determining the absolute quantity of air which the lungs are capable of containing, since a residual quantity, varying in different individuals, remains after the most forcible act of expiration. Nevertheless the results obtained by Mr. Hutchinson are interesting. The vital capacity, in the sense in which this expression is used by Mr. H., is a constant quantity in each individual; that is, each person possesses the ability to expel a certain number of cubic inches of air from the lungs, and, assuming that he remains free from disease, each person, under circumstances equally favorable, will be found to be able to expel at different trials about the same quantity. From a very large number of observations made on persons of different occupations supposed to be in good health, Mr. H. ascertained that the quantity of expired air does not depend on the size of the chest, but sustains a fixed relation to the height of the individual. The law of this relation deduced from an immense number of cases is the following: "For every inch of height (from 5 ft. to 6 ft.) eight additional cubic inches of air at 60° are given out by a forced expiration."

The reason for this relation to height Mr. H. confesses his inability to give. The fact, of course, involves the existence of some circumstances pertaining to the conformation or movements of the chest, which enables individuals in proportion to their height to increase, and diminish, with the alternate respiratory acts, the amplitude of the chest. In other words, the vital capacity is another name for the breathing capacity, dependent on the extent to which the chest may be expanded with the act of inspiration, and contracted with the act of expiration. Dr. Hodgkin attributes it to the "increased length of the dorsal portion of the spinal column." Dr. Sibson offers as an additional reason the greater length and obliquity of the ribs in proportion to the stature, a fact which gives to a narrow-chested tall man a greater range of motion, and consequent breathing capacity, than belong to a short man with a chest of greater depth. These explanations seem probable. A relation less constant was also found to exist between the vital capacity and the weight of individuals.

Mr. Hutchinson supposes that the employment of the spirometer may be made serviceable in determining the existence of thoracic disease. If the vital capacity taken in connection with the height and weight of an individual be considerably below the average, some morbid condition compromising the pulmonary organs may be suspected. But the evidence is only presumptive, for the vital capacity may be reduced by various causes, compromising the muscular power with which the respirations are carried on irrespective of thoracic disease. This must be the case if even slight fatigue of the respiratory muscles will affect the result, and it is stated by Mr. H. that "if more than three observations are consecutively made at one time, the number of cubic inches of air will, from fatigue, generally be found to decrease." The fact is shown by some observations made with reference to this point, and reported by Dr. Wm. Pepper in a communication contained in the American Journal of Medical Sciences, April, 1853.

The consideration just stated, together with the fact, that the variations in different persons within healthy[1] limits is very great, and also the fact, that even when presumptive evidence of thoracic disease is afforded, it gives no information respecting the nature or seat of the affection, will probably prevent this from becoming an important means of examination with reference to diseases of the respiratory apparatus.

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[1] To illustrate the wide interval between extremes in healthy persons, in a series of cases reported by Dr. Wm. Pepper (Am. Jour. of Med. Sciences, April, 1853), in one person 6 ft. in height the vital capacity was 151 cubic inches, and in another person 5 ft. 10½ inches, it amounted to 202½ cubic, inches.

III. TRACHEA, BRONCHI, AND LARYNX.

The trachea, bronchi, and larynx, are separate portions of the canal, or tube leading from the pharynx to the lungs, trasversed by the air in its passage to and from the latter organs. The larynx in addition contains the organs which chiefly compose the vocal apparatus. The three divisions require separate consideration.

TRACHEA.—This portion of the tube extends from opposite the fifth cervical to the third dorsal vertebræ. It pursues a vertical direction, from the larynx to the point last mentioned, where it ends by dividing to form the two bronchi. According to Cruveilhier, it is slightly deflected to the right at its lower extremity. It is from four to five inches in length, varying with the movements of the head and neck; and its diameter is from three-fourths of an inch to an inch in the adult male, being somewhat smaller in the female.

The calibre is generally enlarged at its lower extremity, where it bifurcates. It is composed of from fifteen to twenty cartilaginous rings, with membranous interspaces. The rings, however, are not complete, forming only about four-fifths of a circle. The deficient portion of each ring is situated posteriorly, and the connecting substance is membranous. The posterior one-fifth or membranous part of the tube is flattened.

The anatomical constituents of the trachea in addition to the cartilages are: 1st, a membrane of white inelastic fibres, containing also longitudinal yellow elastic fibres, most abundant posteriorly, by means of which the tube resumes its normal dimensions after having been stretched or compressed; 2d, fibres constituting the trachealis muscle, which enter into the composition of the posterior flattened portion, extending from one extremity of the incomplete cartilaginous rings to the other, and attached, also, to the membranous interspaces between the rings. By the contraction of these muscular fibres the walls of the trachea may be rendered tense, and its calibre diminished; 3d, areolar tissue, forming here, as elsewhere, the medium of the union of the different structures; 4th, mucous membrane, provided with columnar ciliated epithelium and glandular follicles, the latter being most numerous on the posterior surface,—a fact which perhaps explains the greater liability of the membrane to become ulcerated in this situation.

Surrounding the trachea, especially the thoracic portion, are lymphatic vessels and numerous lymphatic glands. The latter are liable to become enlarged by disease, and compress the air-tube so as to modify the sounds produced by the current of air to and fro with the two acts of respiration, and, in some instances, give rise to obstruction sufficient to occasion results more or less serious.

The anatomical construction of the trachea is such that it conforms readily to the varied movements of the head and neck, preserving in all positions a free channel through which the lungs receive the constant supply of atmospheric air necessary to the continuance of life.

The trachea is rarely attacked by disease independently of other parts of the respiratory apparatus. The mucous membrane in this situation is the seat of ulcerations in a certain proportion of cases of tuberculosis of the lungs, and in typhoid fever; it is involved in catarrhal and inflammatory affections, which frequently proceed from the larynx downward to the bronchial tubes; and in that peculiar form of inflammation characterizing the infantile disease called croup, the exudation of lymph often extends below the larynx, sometimes descending to more or less of the bronchial subdivisions.

BRONCHI.—The portion of the air-passages situated below the trachea, and exterior to the lungs, consists of the bronchi. Certain anatomical points pertaining to the size and disposition of these tubes, possess considerable importance in their supposed relations to differences between the two sides of the chest, in the respiratory sounds heard in health and disease, to which reference will be made hereafter.

The lower part of the trachea is contained within the chest, passing behind the upper bone of the sternum, until it reaches the fourth dorsal vertebra, when it bifurcates, forming the right and the left bronchus. The right bronchus diverges from the trachea in a direction nearly horizontal, forming with the latter almost a right angle. Its diameter is about half an inch. It is about an inch in length. Its form and anatomical construction is like that of the trachea, being composed of from six to eight incomplete cartilaginous rings, the posterior portion being membranous and flattened. Before penetrating the lung, which it does at a point equidistant between the apex and the base of the organ, it divides into two branches. The first or upper division is the smaller, and is connected with the upper lobe of the lung. The second, or lower branch, after passing an inch downward, subdivides into two unequal branches, the small one going to the middle, and the larger to the lower lobe.

The left bronchus is considerably smaller than the right, the diameter being about three-eighths of an inch. Its length is about two inches, being twice as long as the right bronchus. Its direction is obliquely downward, forming with the trachea an obtuse angle. It is formed precisely like the right bronchus, embracing from nine to twelve incomplete cartilaginous rings. It subdivides to enter the lung on a level with the fifth dorsal vertebra, about an inch lower than the point where the subdivisions of the right bronchus take place. The number of branches is two, one for each lobe, the lower being somewhat longer than the upper. In size or calibre the two bronchi united exceed the trachea, as the aggregate of the bronchial ramifications within the lungs is greater, in this respect, than that of the bronchi; "so that the velocity of the expired air increases as it approaches the exterior."[1]

The bronchi, like the trachea, are surrounded by numerous lymphatic glands, called the bronchial glands, and this is the case also with the bronchial ramifications within the lungs themselves. Enlargement of these glands occurs in bronchitis, in typhoid fever, scrofula and tuberculosis, pressing on the bronchial tubes, so as to occasion certain acoustic phenomena by modifying the sonorous vibrations incident to the current of air during the respiratory acts, and even producing obstruction, partial or complete, to the transmission of air to the bronchial subdivisions and air-cells.

The bronchi exterior to the lungs are rarely, if ever, the seat of disease not affecting, at the same time, the air-passages, either above or below. Foreign bodies introduced through the larynx, however, frequently become lodged in this situation, giving rise to more or less obstruction, and, if not expelled by acts of coughing, or removed by surgical means, not infrequently causing death by suffocation, or from the effects of protracted irritation. The statistical researches of Prof. Gross, of the University of Louisville, show that foreign bodies become lodged much oftener in the right than in the left bronchus. This may be attributable, in part, to its larger size, but, in the opinion of Prof. Gross, it is mostly due, as was first suggested by Mr. Goodall, of Dublin, to the presence of a spur, or ridge, which Prof. G. calls the *bronchial septum*, projecting upward within the trachea at the point of its bifurcation. This septum is situated, not in the mesial plane, but to the left of it, and therefore serves to direct any substance, especially if of considerable size, into the right bronchus.[1]

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[1] Cruveilhier.

LARYNX.—The larynx is much more complex in its anatomical construction than the other divisions of the air-passages which have been already described. This is owing to the fact that, in addition to conducting air to the lungs for respiration, it contains an apparatus for the production of the voice. To describe the several parts entering into its composition, and their respective offices, would involve details needless so far as concerns the general object of this introduction. For these the reader is referred to treatises on anatomy and physiology. Certain anatomical and physiological points only will be noticed which are of special importance in their bearings on the study of diseases of the respiratory apparatus, and these will be but briefly adverted to.

The more important of the parts which compose the larynx are the thyroid and cricoid cartilages, the epiglottis, and the arytenoid cartilages, the latter movable, and provided with several muscles. These parts are united by several ligaments, and the internal cavity is lined by mucous membrane presenting the same characters as that found in the trachea and bronchi.

The thyroid and cricoid cartilages, with their ligaments, form a solid unyielding box, affording resistance to pressure both from without and within its cavity. In this respect it differs from the other portions of the air-tube, which may be compressed or dilated by a moderate amount of mechanical force. This anatomical point is of importance with reference to certain diseases affecting the larynx. Taken in connection with the narrowness of a portion of the laryngeal canal, the resistance to pressure from within, occasions obstruction, and even occlusion, as results of the deposit of certain morbid products in this situation. It is owing to the circumstances just stated that some diseases of the larynx involve serious embarrassment of respiration, and frequently end fatally by inducing asphyxia. Instances of this kind are exudative or true croup, acute laryngitis with submucous infiltration, and œdema glottidis.

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[1] A Practical Treatise on Foreign Bodies in the Air-Passages, by S. D. Gross, M.D., etc., etc., 1854. This work contains deductions based on the analysis of a collection of nearly fifty cases, embracing, in addition to those coming under the observation of the author and his professional friends, all that were to be gathered from medical literature.

Other points of special importance in their pathological relations are presented when the larynx is examined internally. Viewed from above downward, the laryngeal canal may be considered as divided into three portions, viz.: 1, the superior aperture; 2, the glottis; 3, the inferior space. Of these three portions, the first two are chiefly important. We will notice the points pertaining to these portions respectively under distinct heads.

1. *Superior Aperture of the Larynx.*—This embraces the triangular space bounded by the epiglottis in front, the vocal chords below, and laterally by mucous folds extending from the summit of the arytenoid cartilage to the epiglottis, called the *aryteno-epiglottidean folds.*[1] This portion of the larynx possesses pathological relations of great importance. It is in this situation that the submucous effusion takes place, constituting the affection known as *œdema glottidis.* The areolar tissue uniting the mucous membrane to the subjacent structure, is more loose and extensible here than in other portions of the canal. Hence the liability to serous and puruloid submucous effusions in this situation, forming tumors which, acting like a ball-valve, close the narrow orifice of the glottis with the act of inspiration, producing obstruction to respiration manifested in the inspiratory act, and, unless relieved by appropriate means, often leading to fatal suffocation. The situation of these tumors is such that they are generally within reach of the finger, and their existence may therefore be determined by the touch, rendering the diagnosis of *œdema glottidis*[2] positive. This accessibility also renders relief practicable, in a large proportion of cases, by resorting to incisions, or scarifications with an appropriate surgical instrument, after the method practised with signal success in a number of cases by Dr. Gurdon Buck,[3] of New York; a method of treatment entitled to be ranked among the most valuable of the modern improvements of medical practice. It is an interesting fact that the loose attachment of the mucous membrane at the superior aperture of the larynx which exists in adults, does not obtain in children. In them, the membrane is closely connected with the parts beneath. Hence, œdema glottidis is not a disease affecting children, but occurs only after adult age.

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[1] This space is designated, by Prof. Palmer, of the University of Louisville, the *oval fossa* of the larynx.

[2] Incorrectly called *œdema glottidis*, inasmuch as the œdema is situated above, not at the glottis.

[3] See Transactions of the American Medical Association, Vols. I. and IV.

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2. *Glottis.*—The portion of the larynx called the glottis, is that bounded by the *chordæ vocales*, or vocal chords. The anatomical conformation at this part, and the physiological acts which here take place in connection with respiration, as well as phonation, involve certain facts, not only interesting, but important in their relations to the study of disease. The vocal chords are two in number, on each side; the upper set, formed by folds of the mucous membrane, extending from the bases of the arytenoid cartilages to the anterior inner surface of the thyroid cartilage; the lower, containing fibres of elastic tissue, extend in the same manner from the arytenoid cartilage to the front of the larynx. The upper, or superior vocal chords, are also distinguished as the *false*, and the inferior as the *true* vocal chords. Within the small space between the upper and lower vocal chords, on each side, is a depression or cavity called the ventricle of the larynx. In this cavity foreign bodies, accidentally inhaled into the larynx, sometimes become lodged. By the vocal chords the larynx is greatly narrowed at the glottis. Viewed in the dead subject, the chords diverge from the point of their junction anteriorly, to their attachment at the arytenoid cartilages, leaving a triangular interspace, called the *rima* or chink of the glottis. This fissure is smaller between the lower than the superior vocal chords. In an adult male subject, the antero-posterior diameter of the glottis is ten or eleven lines; and the greatest transverse diameter, *i. e.* at the base of the triangle, from three to four lines, the measurements being made at the narrowest part of the glottis, viz., on a level with the lower vocal chords. In females, the size of the entire larynx is about one-third less than that of the male. At the glottis, in the female subject, the antero-posterior diameter is about eight lines, and the transverse diameter from two to three lines. Prior to the age of puberty, in the male especially, the dimensions of the glottis are less than after the remarkable development in the size of the larynx which occurs at that epoch. The small size of the aperture of the glottis, especially in children, accounts in part for the great danger attending the exudation of coagulable lymph in this situation which occurs in croup.

The foregoing description relates to the glottis in the condition in which it is observed after death. During life, the condition as respects the size and form of the space between the chords, is constantly varying in consequence of movements connected with the use of the voice, and also with the acts of respiration. In speaking and singing the diversities in the tones of the voice are mainly due to different degrees of approximation and tension of the chords, produced by the action of muscles attached to the arytenoid cartilages. The movements involved in vocalization, according to the recent researches of M. Claude Bernard,[1] are governed by influences transmitted exclusively through the spinal accessory nerve. Paralysis of the arytenoid muscles, so far as they are concerned in phonation, is the result of destroying this nerve, the respiratory movements remaining unaffected. Thus, if the nerve be destroyed in a rabbit, the breathing continues undisturbed, but the animal is unable to utter a cry when hurt.[2] This physiological discovery is interesting, and important with reference to the seat and character of nervous aphonia. Local affections of the larynx involving the vocal chords, occasion modifications of the voice, which thus become important diagnostic symptoms. Thus in simple inflammation, or even laryngeal catarrh, as well as in croup, the voice is hoarse and may be temporarily lost; ulceration of the chords from tuberculosis, or syphilis, renders it husky and stridulous, and even the abnormal dryness incident to epidemic cholera occasions a marked effect, amounting sometimes to aphonia. Similar modifications of the sound attendant on cough, are also produced by diseases affecting the glottis, which thus, in the same way, become diagnostic of a morbid condition seated at this division of the air-passages.

The movements of the vocal chords play an important part in respiration. The concurrence of the glottis in certain occasional respiratory acts, especially coughing and sneezing, has long been known to physiologists; but that with ordinary respiration an alternate separation and approximation of the vocal chords take place, accompanying the two acts, inspiration and expiration, appears to have been but very recently ascertained. The interesting and important function referred to, giving rise to what are called the "respiratory movements of the glottis," is fully established by experiments made on living animals by Prof. John C. Dalton, Jr., of New York, the results of which he has reported for the American Journal of Medical Sciences, July, 1854. A dog being completely etherized, the common carotid artery on one side tied, and a dissection made so as to bring into view the glottis, there is found to take place "during normal respiration, a constant and regular movement of the vocal chords, by which the size of the glottis is alternately enlarged and diminished, synchronous with the inspiratory and expiratory movements of the chest." These movements are altogether automatic, and continue to go on even after a large opening has been made into the trachea, admitting an abundant supply of air by the artificial orifice. The size of the *rima glottidis* when dilated with the act of inspiration, may become nearly double that which it has when the vocal chords are in a state of rest; but in this respect there is considerable variation with different respirations, the dilatation being more marked when the breathing is hurried or forced, and on the other hand, marked contraction taking place when the animal whines or cries.

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[1] Recherches expérimentales sur les fonctions du nerf spinal, ou accessoire de Willis, par M. Claude Bernard. Paris, 1851.

[2] The writer witnessed this experiment, made by M. Bernard, during the summer of 1854.

These variations as respects the approximation of the vocal chords with the two respiratory acts, and with different respirations, probably serve to explain, in part, the differences between the sounds of inspiration and expiration emanating from within the trachea and bronchi, and the variations in the characters of sound which each act may present with different respirations, to which reference will be hereafter made under the head of Auscultation.

Abnormal movements of the glottis may become important morbid events. Spasm of the muscles approximating the chords occurs as an element of inflammation of the larynx, both in croup and simple laryngitis. It occurs also as an independent affection in the *laryngismus stridulus* of children, and occasionally in adults, interfering with inspiration, and occasioning distress in proportion to the degree of obstruction from the narrowing of the orifice of the glottis, and, possibly, proving fatal.

The respiratory movements of the glottis are under the control of the recurrent or inferior laryngeal nerves. When these nerves are divided, the glottis remains immovable, neither dilating nor contracting. Under these circumstances the column of air entering the larynx with inspiration forces the chords together and obstructs the orifice, causing death, which takes place more quickly if the animal be young.

3. *Inferior Space.*—This embraces the short space below the vocal chords included within the larynx. In size, form, etc., it resembles the trachea into which it merges, and therefore does not claim a separate description.

SECTION II.

TOPOGRAPHICAL DIVISIONS OF THE CHEST.

For convenience of reference, especially as regards the results of physical exploration, the exterior of the chest is divided into separate spaces, technically called *regions*. These divisions, although wholly arbitrary and conventional, are extremely convenient, and the student before entering on the study of diseases affecting the respiratory apparatus, should make himself familiar, not only with their number, names, and boundaries, but with their anatomical relations respectively to the intra-thoracic organs. To these preliminary points this section will be devoted.

In determining these topographical sections, the sole end being convenience, simplicity, of course, is to be consulted as much as possible. The number of regions should not be needlessly multiplied. The boundary lines, to be recollected and readily ascertained, should be not entirely artificial, but based, so far as practicable, on natural anatomical divisions. And there is an obvious advantage in designating them by terms derived from names already assigned to the parts which they embrace.

The first division is into three surfaces, viz., an anterior, a posterior, and two lateral surfaces. The anterior and posterior surfaces, in fact, may be said to be double, each lateral half of the chest being considered separately.

In many instances it suffices to divide these surfaces into a few fractional parts, after the plan proposed by M. Louis, and followed by other writers. According to this plan, the anterior and posterior surfaces are divided into three parts, and designated the upper, middle, and lower thirds, of the right or left chest; and the lateral surfaces into two equal parts. This is exceedingly simple, and will often answer for reference better than more minute divisions. It is important, therefore, to bear in mind the limits of these fractional sections. They are as follows:

Anterior Surface.—The *upper third* extends from the superior extremity of the chest to the lower margin of the second rib. The *middle third* embraces the space between the latter boundary and the interspace between the fourth and fifth ribs. The *lower third* is the portion of the chest below the line just mentioned.

POSTERIOR SURFACE.—The *upper third* comprises the portion above the spinous ridge of the scapula and a line in the same direction continued to the spinal column. The *middle third* is the space between the lower boundary of the upper third and a transverse line intersecting the inferior angle of the scapula. The lower third is the remainder of the chest below the middle third.

LATERAL SURFACE.—This is divided into two equal portions, called the upper, and the lower lateral half of the right, or the left side of the chest.

Not infrequently it is desirable to refer to localities more circumscribed than the foregoing divisions. Hence it becomes necessary to subdivide more minutely, into what are more properly termed *regions*, than the fractional sections already mentioned. The regional subdivisions which are generally adopted are the following:

ANTERIOR REGION. *a. Post-clavicular*, or *supra-clavicular.*—The space above the clavicle, situated over the projecting portion of the apex of the lung. *b. Clavicular.*—The space occupied by the clavicle. *c. Infra-clavicular.*—Situated between the clavicle and the lower margin of the third rib. *d. Mammary.*—Bounded above by the third, and below by the sixth rib. *e. Infra-mammary.*—The portion of chest below the inferior boundary of the mammary region.

These regions are, of course, double, *i. e.* existing on both sides of the chest. In addition to these, the portion of the chest anteriorly occupied by the sternum is divided into *a*, the *upper*, and *b*, the *lower* sternal region. The two regions just named are separated by a line connecting the lower margins of the third ribs. The space above the sternal notch, the trachea lying beneath, is called the *supra-sternal* region.

POSTERIOR REGION. *a. Scapular.*—The space occupied by the scapula. This space is subdivided into the *upper* and *lower* scapular regions. The former embraces the portion above, and the latter that below the spinous ridge of the scapula. *b. Infra-scapular.*—The space between a line intersecting the lower angle of the scapula, and the inferior extremity of the chest. *c. Inter-scapular.*—The space between the posterior margin of the scapula, and the spinal column.

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LATERAL REGION. *a. Axillary.*—Extending from the highest point in the axilla to a transverse line continuous with the lower boundary of the mammary region. *b. Infra-axillary.*—Extending from the axillary region to the lower limit of the chest.[1]

The relations of these regions, severally, to the organs contained within the chest, are important to be premised. Supposing the divisions to be not confined to the surface, but extended to the centre of the chest, what anatomical parts would each section contain? In answering this question, so far as is practically important, we will notice the different regions, seriatim, in the following order: 1st, those situated anteriorly 2d, those situated posteriorly; and 3d, those situated laterally.

I. Anterior Region.

1. Supra or Post-clavicular.—Beneath this region lies but a small portion of lung, viz., that part of the apex which projects above the chest, rising a little higher on the right, than on the left side. The space, however, is of considerable importance in the diagnosis of certain diseases. The physical signs of tubercle are sometimes early manifested in this situation, the tuberculous deposit generally taking place first at the apex of the lung. Normally, the surface in this region is more or less depressed, forming a concavity. An abnormal increase of this depression will be found to constitute one of the signs of advanced tuberculosis; and, on the other hand, the space is abnormally raised, and perhaps becomes bulging, in another affection, viz., emphysema.

2. Clavicular.—The clavicle extends over the apex of the lung, and the remark just made respecting the importance of the post-clavicular region as a site for the evidences afforded, especially by percussion, of incipient tuberculous disease is here equally applicable.

3. Infra-clavicular.—This is also an important region with reference to the physical signs of tubercle. The signs of all the stages of that disease are usually to be sought for in this region. A section carried to the centre of the chest, embracing the limits of the region, would contain an important portion of the upper lobe of the lung. The bronchi, after the bifurcation of the trachea, situated exterior to the pulmonary substance, are also contained in this sec-

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[1] In designating the limits of the different regions, the author has followed Walshe. The divisions and boundaries, however, are essentially those found in other and prior works.

tion. The bifurcation takes place on a level with the second rib. From this point the bronchi on the two sides diverge, pursuing directions somewhat different, as already described, the right being situated beneath, and the left a little below the costal cartilage of the second rib. The presence of the bronchi gives rise to certain modifications of the sound produced by respiration, in health, as well as disease, which are to be studied in this region; and owing to anatomical differences in the bronchi of the two sides, which have been noticed in Section First, it will be seen hereafter that a natural disparity exists as respects these modifications of respiratory sound. Normally the infra-clavicular region is in most persons slightly convex, different persons differing considerably in this particular. This convexity abnormally increased becomes a sign of emphysema, and an abnormal depression or flattening in this situation frequently attends tuberculosis of the lungs.

4. Mammary.—Some important points pertaining to the anatomy of the intra-thoracic organs, have relation to the space occupied by this region. As respects the organs lying beneath, the two sides differ. A considerable portion of the heart is situated in the left side within its limits, viz., the left ventricle, and auricle, and a portion of the right ventricle. The site of the heart is often distinguished as a separate region, called the cardiac, or præcordia. Over a triangular space extending from the sternum into the left mammary region, the heart is in contact with the walls of the chest. This triangle lies between the fourth and sixth ribs. The limits of the heart beyond this space are to be taken into account in physical exploration. They extend vertically from the upper to the lower boundary of the left mammary region, *i. e.* from the third to the sixth ribs, and transversely in the line of the fourth rib nearly to the nipple. The presence of the heart, as will be seen hereafter, occasions important modifications of the phenomena determined by percussion and auscultation, and disturbs that equality between the right and left mammary regions, as respects the physical signs incident to health, which generally characterizes corresponding localities on the two sides. The disparity just referred to is of practical importance in its bearing on physical diagnosis. Appreciating its degree and extent prevents attributing to changes produced by disease, phenomena which are entirely normal; and, on the other hand, a morbid condition may occasion a notable diminution in the normal disparity. The latter obtains in cases of emphysema, in

5. INFRA-MAMMARY.—This region, like the preceding, has relations, on the two sides, to different organs. On the right side, extending upward, nearly or quite to the superior boundary, is the liver, covered with the diaphragm. The phenomena determined by physical exploration in health, are quite different from those in other regions including pulmonary substance. These phenomena are sometimes attributed to disease by those who overlook the fact that, owing to the presence of the liver, they are normal in this situation. On the left side, this region embraces portions of the stomach, spleen, and left lobe of the liver, but the relative proportion of the different parts lying within the limits of the region varies considerably in different individuals, and still more at different times in the same person. This is owing to the fact that the size of the three organs mentioned is far from uniform in health, and this is true more especially of the stomach. Greater or less distension of the stomach with gas, occasions marked diversities in the phenomena determined by physical exploration of the left infra-mammary region. Enlargement and atrophy of the liver and spleen, also occasion modifications of these phenomena.

In this region, the intercostal depressions, if visible anywhere, are usually more or less marked. The signs of disease which pertain to these depressions are, therefore, to be sought for in this portion of the chest. The evidences of the presence of liquid effusion within the pleural sac, are presented especially in the infra-mammary region.

6. SUPRA-STERNAL.—No portion of the substance of the lungs lies beneath the small space occupied by this region, but the whole of the space is filled by the trachea. In this space, examination is made in studying the phenomena of respiration developed within the trachea.

7. UPPER STERNAL.—Beneath the upper portion of the sternum, at the centre of a line connecting the second ribs, the bifurcation of the trachea takes place. Below this point, the lungs on the two sides are nearly in contact at the mesial line, covering the primary bronchial divisions.

8. LOWER STERNAL.—This part of the sternum covers a portion of the heart, viz., a large share of the right, and a little of the left ventricle. The liver encroaches somewhat on this region, and also the stomach when distended. Situated above the heart, a small portion of the left lung is contained within its limits, and to the right of the mesial line a larger portion of the lung on that side.

II. POSTERIOR REGION.

1. SCAPULAR.—The scapula is situated over the superior and posterior portion of the upper pulmonary lobe, covering also a portion of the upper part of the lower lobe, no other important parts lying beneath it. This region is subdivided into the upper and lower scapular; the former situated above, and the latter below the spinous ridge.

At the upper part of the lower scapular region, terminates the fissure separating the upper and lower lobes of the lungs. From this point of termination, the interlobar fissure pursues an oblique direction downward, passing through the lower axillary and mammary regions to the fifth interspace on the right side, and to the space between the fourth and fifth ribs on the left side. A diagonal line drawn between the two points just mentioned, will mark the situation of the division between the lobes, a matter of interest and importance in the diagnosis of lobar pneumonitis, or inflammation of the substance of the lungs extending over a lobe.

2. INFRA-SCAPULAR.—Pulmonary substance occupies the space within the chest corresponding to this region, on the right side above a transverse line drawn from the eleventh rib. The liver rises to this line. On the left side the lower part of the region contains a portion of the spleen.

The lower lobe on the left, and the lower and middle lobes on the right side, fill the whole of this region above the diaphragm, and also a portion of the scapular region. In cases of inflammation affecting (as is usual) the lower lobe in the adult (lobar pneumonitis) the physical evidences of disease are here presented, and are to be sought for posteriorly, not in front, a small portion only of the lower lobe, as already stated, extending to the anterior part of the chest.

3. INTER-SCAPULAR REGION.—In addition to the substance of the lungs on both sides, the trachea descends into this region, and bifurcates. The point of bifurcation, as already stated, is at the fourth dorsal vertebra. From this point the two primary bronchi diverge, running across the region obliquely downward and outward, the direction on the two sides being somewhat different, as described in Section I. It is in this region behind, and in the infra-clavicular region near the sternum, in front, that examinations are made for the

respiratory sounds developed within the primary bronchi, a matter of interest and importance, as will be seen hereafter.

The topographical divisions of the chest have been described in this section, and the relations of the several regions to the organs lying beneath, stated briefly, but comprehensively enough to prepare the student to enter on the study of physical exploration. The details that have been presented are in themselves dry and uninteresting; nevertheless, they should not only be read and comprehended, but dwelt upon until they become perfectly familiar, as a preparatory step to the subjects which are to follow. In order to obtain a clearer knowledge of the regions, and that the mind may become so familiarized with them as to refer to them, and their important anatomical relations, with readiness, it will be found to be a useful exercise to practise mapping them out either on the patient or on the dead. By marking with India-ink or black paint the boundary lines of the different divisions, their situations, etc., will very soon become firmly impressed on the memory, and much more satisfactorily and usefully illustrated, than by means of pictures or diagrams.

III. LATERAL REGION.

1. AXILLARY.—A section corresponding to the boundaries of this region would contain a portion of the upper lobe of the lungs, with large bronchial tubes.

2. INFRA-AXILLARY.—A section here would embrace, in addition to lung substance on both sides, a portion of the spleen and stomach on the left side, and on the right side the upper part of the liver.

PART I.

PHYSICAL EXPLORATION OF THE CHEST.

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CHAPTER I.

DEFINITIONS—DIFFERENT METHODS OF EXPLORATION—GENERAL REMARKS.

PHYSICAL exploration of the chest is the examination of this region by means of certain methods involving principles of physical science, with a view to determine the existence or non-existence, the nature and the situation, of intra-thoracic disease. Limiting attention to the respiratory organs, various changes in their physical conditions are incident to the different diseases to which they are liable. Among these changes, the study of which belongs to morbid anatomy, are increased and diminished density of the pulmonary organs; loss of substance, leaving cavities; dilatation or contraction of the air-tubes; reduction in volume and displacement from the presence of liquid in the serous-sacs, etc. Owing to the conformation of the chest, the elasticity of its walls, and the movements which they undergo, in connection with the peculiarities in structure of the contained organs, air being constantly present, and in motion to and fro with the acts of respiration, the changes just referred to give rise to certain phenomena appreciable by the senses, and these phenomena are distinguished as the *physical signs* of disease. The discrimination of diseases, so far as these signs are concerned, constitutes *physical diagnosis.*

The following are the different methods of physical exploration:

1. Striking the chest with the finger, or an artificial instrument, in order to determine any deviations from the sounds which are elicited by this process in a condition of health. This method is called *percussion.*

2. Listening, with the ear applied directly to the chest, or through a conducting instrument, to discover morbid sounds produced by the movements of the air in respiration, or by the acts of speaking and coughing. This method is called *auscultation.*

3. Examining the chest with the eye, to see if there are any changes in form or symmetry, and if the visible motions are natural. This method is called *inspection.*

4. Applying the hand to the chest, to ascertain whether any abnormal sensations are appreciable by touch, due to the movements of respiration, and more especially the act of speaking. This method is called *palpation.*

5. Measuring the chest, or parts of the chest, by means of a tape, or graduated measure, to obtain accurate information of alterations in size and mobility. This method is called *mensuration.*

6. Shaking the body, to develope sounds produced when liquid and air are contained in a cavity, which occurs, occasionally, as the result of disease. This method is called *succussion.*

The phenomena resulting from the six methods of examination just enumerated, are called *physical signs*, in distinction from the ordinary symptoms of disease, and the latter are sometimes styled *rational*, *vital*, or *physiological* symptoms. Each of these epithets, as contrasted with the term *physical*, has a certain significance. But the two last are more appropriate than the first, which implies an error, to be noticed presently. The words *signs* and *symptoms*, are often used without any adjective, the first to denote the *physical* and the second the *vital* or *physiological* phenomena of disease. It is convenient thus to employ these simple terms, and there can be no objection to attaching to each the distinctive sense just mentioned, in conformity with conventional usage.

The branch of physical science especially involved in the practice of physical exploration, is that which treats of the phenomena and laws of sound, viz., *acoustics.* An adequate knowledge of physical signs, however, requires only an acquaintance with acoustic principles sufficiently obvious, and with which almost every one is familiar. Although, therefore, it may be true that the study of acoustics will be likely to qualify one to understand more fully and to investigate with greater success the signs based on the facts of that science, this is not necessary in order to comprehend and apply, sufficiently for all practical purposes, the rules of physical diagnosis.

It is a common impression with those ignorant of the subject, that the signs generally represent uniform and definite morbid conditions; in other words, that each sign possesses its own special significance; and, therefore, for the practice of physical exploration, that it is simply necessary to be able to recognize and appreciate certain abnormal sounds. According to this view, physical exploration is merely a mechanical art. This is implied when *symptoms*, as distinguished from *signs*, are called *rational.* The inference is, that to determine the value of signs, processes of reasoning are not required: that they express in themselves their full import, and that the ability to discriminate different diseases thereby depends mainly on manual tact and the cultivation of the senses. The student should, as soon as possible, dispossess the mind of this error. Few signs, individually, are pathognomonic. Their diagnostic signification depends on their combination with other signs, and on their connection with symptoms. Hence, something more than delicacy of hearing and skilful manipulation is requisite. Thought and the exercise of judgment are needed, not less than in determining the nature and seat of diseases by their *vital* phenomena. In short, physical exploration developes a series of facts which are to be made the subjects of ratiocination in their applications to diagnosis, as much as facts obtained by other methods.

To be convinced of the great benefit which practical medicine has derived from the introduction of physical methods of exploration, it is only necessary to contrast the facility of discriminating the most common pulmonary affections at the present time, with the difficulty which confessedly existed prior to the employment of these methods. If the reader will turn to the works of Cullen, or the more recent writings of Good, he will find that these authors acknowledge the inability of the practitioner often to distinguish, by means of symptoms, pneumonitis, pleuritis, and bronchitis from each other, so that for practical purposes it was deemed sufficient to consider these three affections as one disease. At the present time, with the aid of signs, it is very rarely the case that the discrimination cannot be made easily. And that this improvement is mainly due to physical exploration, is shown by the fact, that to distinguish these affections by means of symptoms alone, is still nearly as difficult as heretofore. But to realize the importance of the subject it is not necessary to institute a comparison of the present with the past. It is sufficient to refer to the mistakes in diagnosis daily made by practitioners who rely exclusively on symptoms, which might be easily avoided by resorting to physical signs. It may not be amiss to cite some illustrations from instances that have fallen under my own observation. Examples of confounding the three affections just named are sufficiently common. Of these affections, pneumonitis and pleuritis are not unfrequently latent, so far as distinctive vital phenomena are concerned, and consequently are overlooked. Chronic pleurisy is habitually mistaken for other affections by those who do not employ physical exploration. Of a considerable number of cases, the histories of which I have collected, in a large proportion the nature and seat of the disease had not been ascertained.[1] Yet nothing is more simple than to determine the existence of this affection by an exploration of the chest. Acute pleuritis and pneumonitis are sometimes completely masked by the symptoms of other associated affections, and thus escape detection. This is observed in fevers, and when head symptoms become developed, especially in children. Under these circumstances, the practitioner who avails himself of physical signs is alone able to arrive at a positive conclusion as to their existence. Emphysema is an affection which cannot be recognized by symptoms alone, and hence, they who neglect signs have no practical knowledge of it. Acute tuberculosis I have known repeatedly to be called typhoid fever; on the other hand, I could adduce numerous examples of different affections erroneously considered to be phthisis, and a still greater number of instances in which patients with this affection were incorrectly supposed to be affected with some other disease than tuberculosis. Were we to dwell upon these, and other mistakes which might be added, it would be easy to show that they are unfortunate, not merely in a scientific point of view, but with reference to practical consequences involving the welfare, and it may be the lives of patients.

The physical exploration of the chest has certain striking advantages which may be briefly noticed. The phenomena thus developed are entirely *objective*. They have no connection with the mind of the patient. They are therefore free from the difficulties and liabilities to error arising from ignorance, deception, self delusion, disposition to exaggeration, or desire of concealment, which belong to *subjective* symptoms. They are available in children too young to give information respecting their diseases; in cases of mental derangement, and in the condition of coma. The evidence which they afford of morbid conditions is more positive than that furnished by symptoms. Frequently in attempting to arrive at a diagnosis by means of the latter, we can only reach an approximation to certainty. In forming conclusions we are obliged to balance probabilities. This uncertainty, of course, influences the management of disease. But the information obtained by the aid of signs is often so complete and precise, as to leave nothing more to be desired. The proof of the existence of certain affections is exact and demonstrative, leaving no room for hesitation. Physical signs are more readily and quickly available than symptoms. Diagnosis is thus more prompt, as well as more positive. Hence diseases are recognized at an earlier period, a point often of very great consequence as regards successful treatment. Their value is frequently as conspicuous negatively as positively; that is, deductions from their absence are as important and decisive as from their presence. Finally, in view of the considerations just presented, this branch of practical medicine affords to the practitioner a sense of gratification greater than that which he derives from clinical investigations by means of symptoms.

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[1] Vide. Clinical Report on Chronic Pleurisy, by the author.

By thus directing attention to some of the points of contrast between symptoms and signs, it is not to be concluded that these two classes of phenomena hold conflicting relations in the practice of medicine. Neither is to be employed in diagnosis to the exclusion of the other. They are not to be disconnected save for abstract consideration. They are always to be brought to bear conjointly in clinical investigations; combined, they lead to conclusions which neither may be competent to establish alone. They mutually serve to correct or confirm deductions drawn from either separately. It is never to be lost sight of in the study or practice of physical exploration, that to devote too exclusive attention to signs, is as much a fault as to ignore their value, and rely entirely on symptoms.

Notwithstanding these advantages, and the importance of physical exploration in the diagnosis of diseases affecting the respiratory apparatus, it is employed by only a small proportion of medical practitioners. Some even now profess to attach but little value to signs; a much larger number practically repudiate them. This fact, however, may be stated, viz., no one who has devoted sufficient attention to the subject to apply successfully the well-established rules of physical diagnosis at the bedside, has ever denied having received great assistance therefrom, or advocated a neglect of them. They who depreciate and forego the benefits of physical methods of examination, have had little or no experience of their practical application. If the foregoing assertion be true, the explanation of the fact that this branch of practical medicine is properly estimated and cultivated by so few, is to be sought for in causes discouraging the pursuit, or in difficulties attending it which are not easily surmounted. Such causes and apparent difficulties exist. It is a common impression that it is useless to attempt to accomplish anything satisfactory in physical exploration unless the sense of hearing be singularly apt to distinguish nice shades of difference in sounds; and in addition to this, extraordinary application and opportunities are supposed to be indispensable. The pursuit is generally regarded as extremely complicated, requiring an experienced teacher and a large hospital, to be prosecuted with success. These ideas do great injustice to the subject. So far as the more important diagnostic principles are concerned, both in their apprehension and application, they are exceedingly simple. The points which are abstruse or intricate, as a general remark, are those which are of the least practical consequence. Oral instruction by an expert, with explanations and illustrations at the bedside, are undoubtedly of very great use, as well as the selection of cases which a large hospital affords. But I venture to assert with positiveness, that these advantages, although desirable, are not essential; and that an intelligent student or practitioner, solely with the aid of books, and with opportunities for observation which may be enjoyed in every village, may, by means of a very moderate amount of exertion, acquire a practical knowledge of physical signs sufficient for ordinary purposes of diagnosis.[1]

A tithe of the time so often occupied by medical students in becoming very indifferent performers on some musical instrument, would more than answer to make them adepts in the practice of physical exploration. Acuteness of the sense of hearing, and an ear for music, are doubtless useful qualifications; but the sounds to be recognized and distinguished from each other, are generally easily discriminated, and I have known tolerably good auscultators who were not only unable to appreciate musical notes, but who labored under some degree of deafness.

In treating of physical signs, they are to be considered under two aspects. The first and more important is the significance and value which belong to them separately and in combination. What are the abnormal conditions which they represent? This question covers all that pertains to the practice of physical diagnosis. In a practical treatise, therefore, the facts embraced in this view of the subject are of paramount importance. How are these facts ascertained? in other words, in what manner is our knowledge of signs, as the representatives of morbid changes, obtained? Physical phenomena become signs of disease whenever it is established that there exists a constancy of association of these phenomena with the physical alterations which disease induces. Being uniformly found together, a connection between the two is logically proved, so that the former may be regarded as the indices of the latter. This is the basis of the science of physical exploration. And this constancy of association is determined by clinical observations together with the information derived from post-mortem examinations. Certain sensible phenomena observed during life are found uniformly present in cases in which dissection reveals certain morbid changes. Hence, whenever particular phenomena are recognized, we are authorized to infer the existence of corresponding morbid conditions; the phenomena in this way become signs, and, conversely, whenever certain morbid conditions are ascertained to exist prior to death, we look for the physical phenomena, or signs, which previous observations have shown to coexist with them. In short, the evidence of the value and significance of signs rests on experience. This is a fact not to be lost sight of in the study of physical diagnosis, and especially in the endeavor to contribute additions to our knowledge of the subject. Much as has been already accomplished, there is ample scope for further researches in this direction. Many questions of practical interest and importance are open for investigation by means of the analysis of recorded observation in the living and dead subject. The application of the numerical method to the study of physical signs, so far from having been completed, has hardly been as yet commenced. Much is to be expected from this source which will give greater precision to our knowledge, as well as enlarge its boundaries. Another point pertaining to the cultivation of this pursuit, the importance of which does not appear to have been sufficiently appreciated, may be here noticed. I refer to careful and systematic explorations of the healthy chest. The results of such examinations constitute, of course, the point of departure for determining the phenomena of disease. In this way only are to be ascertained variations from the phenomena usually observed, which are liable to take place irrespective of disease, *i. e.* within the limits of health. In subsequent chapters will be adduced results obtained by an analysis of a series of explorations made in subjects presumed to be entirely healthy, the phenomena being recorded at the moment of observation. These researches might be extended with advantage. Our knowledge of healthy physical signs is not yet complete, and in proportion as it is defective are we liable to error in judging of the signs of disease.

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[1] I would not be understood, by these remarks, to undervalue the importance of a master's instruction; but for the encouragement of those who may not be able to avail themselves of this advantage, in connection with hospital opportunities, I desire to express the conviction that, without them, a proficiency sufficient for discrimination, in a large proportion of the cases occurring in medical practice, is attainable.

A second aspect under which physical signs are to be considered is the mechanism of their production. This is the theoretical part of the subject, and is to be pursued with great circumspection. The endeavor to account for the results of physical exploration opens a wide range for speculation. *A priori* conclusions as to the phenomena which ought to accompany certain physical changes, are not admissible except as temporary hypotheses to be tested by the results of clinical and post-mortem observations. Experiments made on the dead subject, and merely artificial contrivances, in order to imitate the sounds which characterize certain signs, or to prove the correctness of certain hypothetical explanations, are to be received with a certain amount of distrust, for it is almost impossible to ascertain and reproduce all the physical elements which are combined in the living body. There is reason to believe that this attempt has given rise to false views, to which reference will be made hereafter. Desirable as it undoubtedly is to understand as fully as possible the rationale of physical signs, their importance and availability in diagnosis by no means depend on the attainment of this end. Several of the signs will afford illustrations of the truth of this remark; its correctness, indeed, is implied in the fact already stated, viz., that our positive knowledge of the significance and value of signs is based on experience.

In entering on the study of physical exploration the first object should be to become acquainted with the ascertained facts and general principles pertaining to the subject. It is sometimes advised that the student should at once commence clinical observations without any previous acquaintance with the signs which characterize disease. This is to place him in the position of the original explorers, without, it may be presumed in most instances, their genius and industry! Progress in this way must be slow, and unsatisfactory, compared with that which may be made by availing oneself at the outset of the labors of others. Certain practical points have been established. These are to be understood by resorting to oral instruction or books, and as fast as practicable they are to be verified by actual observation. The latter is rendered less difficult by the fact, as will be seen hereafter, that a large share of the signs of disease are exemplified in the living healthy subject. The signs developed by the different methods of exploration are to be studied singly and combined. Isolated from the others, the knowledge pertaining to each has relation to its sensible characters, the manner in which it is developed, its significance and diagnostic value, and the probable explanation of the mode of its production. It is, however, as already intimated, very rarely the case that the diagnosis rests on a single sign. Various signs are generally associated, and it is by their combination that we are enabled to arrive at positive conclusions as to the nature, seat, or stage of diseases. Were it necessary to rely exclusively on the special significance of individual signs, the application of the results of physical exploration to diagnosis would be much more limited than it is. By uniting the information derived from the different methods of examination, its scope is greatly enlarged. Moreover, in determining the existence of individual signs, our observations are rendered positive, or otherwise, by reference to their combinations. The mutual relations, therefore, of the different signs constitute a highly important branch of the subject. Separately, the signs may be compared to the words which compose a language; the laws of their combinations are analogous to syntax. A knowledge of both is necessary in order to interpret correctly the physical expression of disease.

For the successful practice of physical exploration the facts and principles pertaining thereto must not only be understood, but they must be at command, so as to be readily available. The practitioner must be qualified to appreciate characteristic sounds, and determine the value of their combinations, without waiting to refer to authorities, or even for deliberate meditation. The signs must be made as familiar as household words. This is to be attained by practice, and preserved by constant exercise. Every one accustomed to practise physical exploration, must have noticed that after an intermission in its employment for some time, the usual facility and quickness in arriving at satisfactory results is temporarily somewhat impaired. For this reason, were there none other, the habit of daily examining the chest, to a greater or less extent, in all cases, is to be recommended.

In treating of the principles and practice of physical exploration in the following pages, the aim will be to present facts and considerations which have direct practical bearings on diagnosis. Inquiries purely theoretical or relating remotely to the discrimination of diseases, and discussions of mooted points, will receive but little attention. Such inquiries and discussions, for the most part, have reference to the mechanism by which the phenomena detected by the different methods of exploration are produced. To this department of the subject I shall devote, relatively, but a small space, in part from a conviction that the advantage of the reader will thereby be consulted, and it is but candor to add, also, because my own studies have been chiefly confined to clinical observations.

CHAPTER II.

PERCUSSION.

Exploration by percussion consists in striking the chest so as to induce sonorous vibrations. In consequence of the elasticity of the thoracic walls, and the presence of air in the pulmonary cells, a certain degree and kind of sonorousness is produced when strokes are made in a manner to elicit sound; and various changes in these physical conditions incident to disease, occasion corresponding deviations from the type of sonorousness pertaining to a healthy state. Percussion may be practised in different modes. As first introduced by Auenbrugger, in 1761, the blows were applied directly to the chest, without any intervening medium. This is called *immediate* percussion. For obvious reasons this mode is objectionable, and is now nearly obsolete. Shortly after the more recent discoveries by Laennec, which served at once vastly to enhance the importance of the method of exploration under present consideration, *mediate* percussion, as it is termed, was employed by M. Piorry, of Paris, and has since been generally adopted. In mediate percussion the blows are made on an intervening solid medium, applied to the chest, and styled a *pleximeter*. The pleximeter used by Piorry is a thin oval disk of polished ivory, about two inches in length, and an inch in its greatest width, with an upright border at both extremities projecting about half an inch. These projections serve as handles by which the instrument is adjusted, and held in contact with the thoracic walls. On one side a scale for measurement is sometimes marked in black lines, which is often useful in determining accurately spaces and distances on the chest. Piorry's pleximeter is generally employed in the Parisian hospitals, and to a considerable extent in other countries than France. Other substances have been recommended. A square block of caoutchouc forms a convenient pleximeter, and is preferred by M. Louis and some others. A circular piece of sole leather, 1¼ inches in diameter, fixed in a steel stirrup, so as to be movable on a point connecting the extremities of the sent, however, the general rule is the same, viz., less sonorousness, and a higher pitch on the right side.

5. INTERSCAPULAR REGION.—In this region a certain amount of sonorousness exists, notwithstanding the mass of muscular substance. Without having preserved recorded observations, I should say, in general, the degree of sonorousness is greater than in the scapular region below the spinous ridge, although Walshe states that, in this respect, it holds an intermediate place between the infra and supra spinous spaces. The vesicular quality of sound is feeble. The degree of sonorousness is less, and the pitch higher on the right side in some persons, but I have not taken pains to obtain data bearing on the ratio of instances in which disparity in these points is to be observed.

6. MAMMARY REGION.—The mammary region offers marked differences on the two sides, owing to the presence of the upper convex extremity of the liver, covered with lung substance, in the right, and the situation of the heart in the left side of the chest. From the fourth rib, on the right side, diminished resonance is appreciable, which increases as percussion is made downward to the point where the pulmonary sound ceases. This point marks what may be called the *line of hepatic flatness*, *i. e.* the lower border of the lung. This point, which is somewhat variable in different persons, usually falls a little below the lower boundary of the mammary region, or the sixth rib. Next to the sternum, on this side, between the third and fifth ribs, the presence of a portion of the right auricle and ventricle, occasions diminished sonorousness over a space extending about a finger breadth from the right margin of the sternum.

On the left side, diminished resonance exists in the præcordial space, and over a portion of this space, in which the heart is in contact with the thoracic walls, there is almost complete absence of sonorousness. Percussing in a vertical direction from above downward, midway between an imaginary line passing through the nipple, and another line coincident with the left margin of the sternum, diminished resonance exists at the upper border of the mammary region, viz., the third rib. At the fourth rib, on a horizontal line passing through the nipple, resonance nearly ceases, in consequence of a portion of the heart in this situation being uncovered by lung. From the fourth to the sixth ribs, the absence of resonance continues, and extends more and more to the left of the sternum, the inner border of the left lung receding, so as to leave the heart in contact with the wall of the chest over a trian India-rubber rim surrounding the ear-piece is employed as a percussor. This originated with Dr. Marsh. Professor Bigelow, of Boston, recommends a ball of worsted, covered with velvet, to which a handle is attached. Most practitioners, however, are satisfied with one or more of the fingers of the right hand, bent in a half circle; which certainly, in most instances, answers all practical purposes.

The mode of performing percussion is a point of practical importance. It is not at once an easy matter to strike so as to produce in the most satisfactory manner sonorous vibrations. Certain rules are to be observed, and success depends on a tact to be perfected by practice. The fingers are to be flexed so that their ends shall fall perpendicularly on the pleximeter. The strokes are not to be made with the pulpy portion of their extremities. The blows should be given with a certain quickness, the fingers brought into contact with the pleximeter and withdrawn as it were instantaneously, by a movement limited almost entirely to the wrist joint. When a light percussion is desired, the index or middle finger alone may be employed, but when greater force is requisite, two or three fingers should be used conjointly. In the latter case, it is generally recommended to bring the three fingers together as compactly as possible, and support them with the thumb. I find it better to arrange the fingers on a line and percuss without bringing forward the thumb into apposition. With the thumb free, the movements at the wrist are unrestrained, and the fingers do not need any additional support. The type of perfect percussion is witnessed in musical performances, on a series of bells representing the different notes of the gamut. It is also seen in the manner in which the little hammers strike, and rebound from the strings of a piano-forte when the keys are touched. The object in these examples is precisely the same as in percussing the chest, viz., to elicit sounds as distinct and pure as possible, and they may therefore be taken as models for imitation. It is generally easy to know at a glance, by the mode in which percussion is made, whether it is resorted to in order to develope physical signs with the import of which the practitioner is practically familiar, or whether it be employed merely for form's sake, or to affect an acquaintance with the subject. Rules of manipulation pertaining to the practice of percussion, in addition to the foregoing, will be given presently.

A mode of practising percussion, involving, for certain purposes, an important improvement, was proposed some time since, by Dr.

G. P. Cammann,[1] and Prof. A. Clark, of New York. The peculiarity of this mode consists in combining with percussion, another of the methods of exploration, viz., auscultation. Percussion is made with a pleximeter, while the ear is applied to a cylinder of wood, a stethoscope, placed in contact with the chest. This may be distinguished as *auscultatory percussion.* Its advantages consist in the better transmission of the sonorous vibrations than when communicated through the intervention of the atmosphere, and in the greater distinctness with which differences in the pitch and quality of sounds are appreciated. It is particularly useful in determining the boundaries of the solid organs, other than the lungs, which encroach on the thoracic space, viz., the heart, liver, and spleen. Auscultatory percussion, however, is rarely resorted to, because, for ordinary purposes, the other and simpler modes suffice. In some instances, for example, when it is desirable to ascertain with exactitude the space occupied by the heart, it may be employed with advantage.

In treating of the results of percussion we are to consider, *first*, the phenomena pertaining to health; and, *second*, those which are to be regarded as the physical signs of disease.

PERCUSSION IN HEALTH.

Percussion made on certain parts of the chest of a person in health, for instance at the summit, in front, developes a resonance which is peculiar. The quality of sound is highly characteristic, and cannot be well described, or illustrated by comparison. This quality, or *timbre*, is due in a great measure to the fact that the air within the chest is contained in an immense number of minute spaces—the air-vesicles. The sonorousness denotes the presence of air, and the contrast, in this respect, is readily shown by percussing first the chest, and next a portion of the body composed of a solid mass of bone and muscle, for example the thigh. The peculiar quality of sound is appreciated by percussing the chest, and afterward the abdomen, provided the stomach or intestines are somewhat flatulent. In the latter instance the sonorousness arises from the presence of gas in a free space of considerable size. This species of resonance, in distinction from that due to the presence of air in the lungs, is called *tympanitic resonance.* The same hollow quality of sound is elicited, for reasons which will be presently mentioned, by percussing certain portions of the thorax in health; and it becomes also, as will be seen hereafter, under certain circumstances, a physical sign of disease. It is thus called in consequence of its type being the sound produced by percussing the abdomen distended by gas, in other words in a tympanitic state. On the other hand, the sound peculiar to the chest may be distinguished as the *pulmonary or vesicular resonance.* The words pulmonary or vesicular, indicate the peculiar quality referred to. The latter, *vesicular*, is perhaps preferable, and I shall therefore employ it. In using the term, however, it is not to be understood that the character of sound would suggest *à priori* the existence of air-vesicles, but its appropriateness is based on the fact that the distinctive quality of the resonance is attributable to distention of the vesicles by air. In addition to its peculiar quality, the vesicular resonance has a certain pitch, and in this respect, compared with most abnormal sounds, it is low or grave. The sound also has a certain duration and degree of intensity.

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[1] New York Journal of Medicine, July, 1840.

As regards the sonorousness in the four aspects just mentioned, viz., vesicular quality, pitch, duration, and degree of intensity, percussion practised in the same manner on the chests of different persons in health, by no means developes identical results. This may be demonstrated by placing a number of persons in a row, and percussing their chests, severally, in succession, in the same situations. The sound in no two of the persons, perhaps, will be exactly alike. It will present marked differences in the vesicular quality, in pitch, in duration, and in the degree of intensity. This is owing to differences in the elasticity of the thoracic walls, in the volume of the pulmonary organs, in the amount of muscular and adipose tissues covering the chest, and other circumstances not so easily appreciated.

Nor is the percussion sound the same over every portion of the chest in the same individual. In corresponding situations, on the two sides of the chest, however, with certain exceptions, the phenomena developed by percussion are usually considered to be identical, or nearly so. This is a very important rule in its bearing on physical exploration. It may be said to be of fundamental importance in estimating certain variations from the normal sounds constituting the physical signs of disease, inasmuch as the latter are often determined not so much by reference to an ideal standard of health, as by comparison of one side of the chest with the other side. As respects normal resonance, equality of the two halves of the chest, with some exceptions is assumed. Were we not warranted in doing so to an extent sufficient for most practical purposes, it would sometimes be extremely difficult to decide whether or not the phenomena developed by percussion denoted disease; and the same is not less true of other methods of exploration than of percussion. But it is obviously important to ascertain as completely as possible the deviations from this rule of equality, which may exist within the limits of health; otherwise there is a liability that such deviations may be mistaken for the physical evidences of disease. As already intimated, there is room for investigations with reference to this point. In order to determine to what extent and in what particulars disparity between corresponding portions on the two sides may be compatible with health, examinations are to be made of the chests of persons, selected for that purpose, who are presumed to be entirely free from pulmonary disease; the phenomena must be carefully recorded, and a collection of facts thus obtained, subjected to analysis. I shall give, to some extent, results of such an investigation as regards percussion, and the other methods of exploration, the number of examinations not being large, but sufficient to establish certain deviations, and to illustrate the importance of a field of study which is by no means exhausted. We will now proceed to a comparison of the several regions of the chest on the two sides respectively.[1]

1. POST-CLAVICULAR REGION.[2]—Percussion in this situation generally elicits a pretty clear resonance, the vesicular quality being most marked in the central portion. Toward the sternal extremity, owing to the proximity of the trachea, the quality of sound is somewhat tympanitic, and this quality predominates in proportion as the direction of the percussion-strokes is toward the trachea. The resonance in this region is greater in females than in males. It is very difficult to apply above the clavicles the finger used as a pleximeter equally on the two sides; and if an ivory or other artificial instrument be employed, an inclination toward the trachea, slightly greater on one side than on the other, modifies the sound sufficiently to produce a disparity between the two regions in the pitch and quality of the resonance. In making comparative observations in healthy subjects,

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[1] The examinations of corresponding regions of the two sides, the results of which are given, were made in persons not only free from all appearances of disease, but also from any apparent deviation from the symmetrical conformation of the chest. Deformities of the chest, either congenital or resulting from disease, will, of course, occasion disparity between the two sides in the phenomena developed by physical exploration, as will be mentioned further on.

[2] For the boundaries of the regions, see Introduction, Section II, page 54, et seq.

I have found it almost impossible to produce uniform results with repeated percussions. This should enforce caution in regarding an apparent difference, if it be slight, as a morbid sign. To denote disease, the difference must be well-marked and constant. With proper care, and making due allowance for disparity arising from inequality in the performance of percussion on the two sides, important evidence of the existence of disease is sometimes obtained by percussing in this situation, in cases of tuberculosis of the lungs.

2. CLAVICULAR REGION.—Over the clavicles the resonance is somewhat tympanitic near the sternum, from the proximity of the trachea; on the central portion, the vesicular quality is apparent, and at the acromial extremity the sound becomes comparatively dull. Equal percussion can be made on the two sides in this region, without difficulty. A slight disparity, however, is not unfrequently appreciable in health, and when the chest appears to be symmetrical, owing, probably, to some difference in the size and curves of the bone. A slight difference in these respects in well-formed chests, is sometimes apparent on examination with the eye and by the touch. To be considered an evidence of disease, a disparity in the resonance should be well-marked, constant, and associated with a corresponding variation in the percussion-sound of the two sides, either in the post-clavicular or infra-clavicular regions, or in both.

3. INFRA-CLAVICULAR REGION.—Percussion here elicits, generally, a resonance more marked than elsewhere, save in the axillary region, and in some persons, below the scapula, behind. In this situation examination is to be made carefully for the physical signs of the early stage of tuberculous disease; and a slight disparity in the percussion-sound, taken in connection with other signs, and with symptoms, is held to constitute strong evidence of a deposit of tubercle. With reference to the diagnosis of incipient phthisis, the deviations from the rule of equality at the summit of the chest, incident to health, are highly important to be taken into account. Of twenty examinations of persons apparently free from disease, and whose chests were symmetrical in conformation, in eight the percussion-sound was in all respects equal on the two sides, and in twelve, there existed disparity to a greater or less extent. The points of disparity noted were as follows. In ten, the degree of resonance was greater on one side than on the other. In all of these ten instances there existed a greater degree of resonance on the left side. In one instance, however, the resonance was greater on the right

side, save at the portion near the sterno-clavicular junction; at this portion it was greater on the left side. In eleven instances, embracing all the ten persons just referred to, and one in addition, the pitch of resonance was somewhat higher on the right than on the left side.[1] In one of these cases, the same mentioned above, the pitch was higher at the sterno-clavicular junction on the right and over the rest of the region on the left side. In four instances, it is noted that the vesicular quality of the resonance was greater on the left side, and in no instance was this observed on the right side. Pains were not taken to observe and note this point in all the examinations. The resonance was relatively tympanitic[2] in its character on the right side in one instance, and in one, also, on the left side; with respect to the duration of sound, observations were not made; the disparity in degree of resonance and pitch found in the majority of instances, was generally slight, but sufficient to be distinctly appreciated on repeated careful percussion. It thus appears that in the majority of persons in health, having well-formed chests, there is not an absolute equality in the resonance existing at the summit of the chest in front on the two sides. It appears, also, that, as a general rule, the disparity consists in a greater degree of resonance, more vesicular quality, and, relatively, lowness of pitch, on the left side. The tympanitic quality is occasionally found on one side, which may be either the left or the right. The practical bearing of these facts will appear hereafter; the facts rest on observation, and are independent of any explanation that may be offered. Theoretically, in view of the greater capacity of the right chest, it would seem perhaps more reasonable that the difference between the two sides should be the reverse of that which is found to exist. The larger development of the right pectoral muscle, in consequence of the greater use of the right upper extremity, may account for the fact in some instances, but the disparity exists in cases in which there is no apparent difference in the muscular covering, in this situation. Possibly the different physical conditions at the base of the thorax may afford an explanation. On the right side the lungs repose, with the diaphragm intervening, on the liver, which occupies the whole of the base on that side. The presence of this solid viscus may slightly deaden the sound. On the left side below the lung is situated the stomach, frequently more or less distended with gas, and the effects of this, it may be supposed, is to increase the sonorousness on that side, even at the summit, independent of the transmission of the tympanitic gastric sound which is sometimes observed.

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[1] These results, as respects pitch, differ very considerably from those obtained in twenty-two examinations made with reference to this point in 1852. (Prize Essay, by author.) In these twenty-two examinations disparity of pitch in this region was noted in two instances only. The ratio of instances in which points of disparity are presented would be expected to differ somewhat in different collections of cases, but so great a difference would not have been anticipated. I am disposed to explain it in part by the fact that the more recent examinations were made with a greater closeness of observation, in order to appreciate the slightest degree of disparity.

[2] By the term tympanitic, I mean a non-vesicular sound, without reference to intensity.

4. Scapular Region.—I enumerate this region next to the preceding because, being at the summit of the chest, its relations in diagnosis are similar. Like the infra-clavicular, it is an important region with reference to the physical signs of phthisis. The normal degree of resonance over the scapula is much less than at the summit in front, for sufficiently obvious reasons. The vesicular quality of resonance is less apparent. A distinct sonorousness, however, exists here, notwithstanding the percussion has to be made on a layer of bone, and a mass of muscle placed upon it. These circumstances do not deaden the sound sufficiently to render the region nearly or even quite unimportant in physical exploration, as stated in a recent work on diseases of the chest.[1] On the contrary, percussion in this situation is often of great utility in the diagnosis of tubercle. The region is subdivided into the *supra* and *infra* spinous portions. The sonorousness is greater over the latter.

In thirteen of twenty observations, relative to the comparative resonance in the scapular region, on the two sides of the chest, no disparity was apparent. In four of twenty observations, the resonance was less on the right than on the left side. In a single instance the resonance was greater on the right side. In the latter case there was tympanitic resonance in front and laterally. In three instances it was noted that the pitch of resonance was higher on the right side. In two instances this was true of the left side. In both the latter instances tympanitic resonance existed in front on the left side. In two instances the resonance was tympanitic over the left scapula, and in no instance was this noted of the right.

Disparity between the two sides thus appears to be present in a less proportion of cases at the summit behind than in front. When present, however, the general rule is the same, viz., less sonorousness, and a higher pitch on the right side.

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[1] Swett on Diseases of the Chest.

5. INTERSCAPULAR REGION.—In this region a certain amount of sonorousness exists, notwithstanding the mass of muscular substance. Without having preserved recorded observations, I should say, in general, the degree of sonorousness is greater than in the scapular region below the spinous ridge, although Walshe states that, in this respect, it holds an intermediate place between the infra and supra spinous spaces. The vesicular quality of sound is feeble. The degree of sonorousness is less, and the pitch higher on the right side in some persons, but I have not taken pains to obtain data bearing on the ratio of instances in which disparity in these points is to be observed.

6. MAMMARY REGION.—The mammary region offers marked differences on the two sides, owing to the presence of the upper convex extremity of the liver, covered with lung substance, in the right, and the situation of the heart in the left side of the chest. From the fourth rib, on the right side, diminished resonance is appreciable, which increases as percussion is made downward to the point where the pulmonary sound ceases. This point marks what may be called the *line of hepatic flatness*, *i. e.* the lower border of the lung. This point, which is somewhat variable in different persons, usually falls a little below the lower boundary of the mammary region, or the sixth rib. Next to the sternum, on this side, between the third and fifth ribs, the presence of a portion of the right auricle and ventricle, occasions diminished sonorousness over a space extending about a finger breadth from the right margin of the sternum.

On the left side, diminished resonance exists in the præcordial space, and over a portion of this space, in which the heart is in contact with the thoracic walls, there is almost complete absence of sonorousness. Percussing in a vertical direction from above downward, midway between an imaginary line passing through the nipple, and another line coincident with the left margin of the sternum, diminished resonance exists at the upper border of the mammary region, viz., the third rib. At the fourth rib, on a horizontal line passing through the nipple, resonance nearly ceases, in consequence of a portion of the heart in this situation being uncovered by lung. From the fourth to the sixth ribs, the absence of resonance continues, and extends more and more to the left of the sternum, the inner border of the left lung receding, so as to leave the heart in contact with the wall of the chest over a triangular space, the widest part of which is indicated by a horizontal line touching the fifth rib at a point a little within the nipple. Percussing horizontally from the sternum outward on a line passing through the nipple, resonance is nearly absent to within about a finger's breadth of the nipple. Diminished resonance, however, is appreciable quite to the nipple, and even a little beyond it, owing to the fact that the heart extends thus far covered by lung. The presence of the heart in the left side thus gives rise to alterations in the percussion-sounds which are twofold. *First*, absence, nearly or quite, of vesicular resonance. This is the case over the space in which the left lung fails to cover the organ. *Second*, diminished resonance over an area extending a certain distance beyond the boundaries of that space. The precise limits of these two areas are important in connection with the study of diseases of the heart. Variations in the degree of resonance in the præcordia are also involved in the diagnosis of pulmonary affections. In health the degree of resonance is different with the two acts of respiration, and may be affected voluntarily by increasing the extent of inspiration and expiration. By inspiration a larger portion of the heart is covered by lung than in expiration; on the one hand, the space covered by means of the former, and, on the other hand, that uncovered by means of the latter act, other things being equal, are proportioned to the forced expansion of the lung, and the contraction alternating with the two acts. A morbid condition of the lung, consisting in permanent distension of the air-cells (which obtains in emphysema), will, of course, diminish the space over which, in health, resonance is nearly or quite absent. Abnormal resonance in the præcordia, hence, becomes a physical sign of that affection. On the other hand, atrophy of the lung would have a contrary effect. Considerable differences as respect the extent to which the resonance is diminished, and also the limits of the two areas are observed in different persons in whom the lungs are perfectly healthy. In other words, the lung overlies the heart more in some individuals than in others, of which fact percussion furnishes physical evidence.

The mode of performing percussion in order to develope, *first*, the *flatness* due to the contact of the heart with the thoracic wall; and, *second*, the *dulness* occasioned by the presence of that portion of the organ which is covered by the lung, is somewhat different; and this difference, which involves a rule applicable to the practice of percussion in other situations, both in health and disease, may as well be mentioned in the present connection. In determining the space which the heart occupies, uncovered by lung, percussion should be lightly made; but to fix the boundaries to which the organ extends covered by lung, beyond this space, greater force of percussion is requisite. The difference in the practical results of these two methods of percussing was first pointed out by Piorry. In general, a light percussion reveals physical conditions pertaining to parts situated directly beneath the thoracic walls; while a more forcible percussion, the blows being made to bear on parts more deeply seated, is necessary to obtain information of the physical condition of parts situated more or less beneath the surface of the lung. To the first mode, Piorry gives the name of *superficial percussion* (*percussion superficielle*); and the second mode he calls *deep percussion* (*percussion profonde*). Forcible or deep percussion is necessary to determine the existence and the size of indurations of lung from partial pneumonia, pulmonary apoplexy, or tuberculous deposit, which are removed, to a greater or less distance, from the surface of the lung.

Although a portion of the heart is in actual contact with the thoracic walls, the percussion-sound over this space, is rarely totally devoid of resonance, *i. e.* absolutely flat. This is probably owing to the fact that the percussion, more especially when made on a rib, in consequence of the elasticity of the latter, is not limited in its effects precisely to the point percussed, but extends over a greater or less area, and is thus brought to bear on the lung in near proximity, sufficiently to produce some degree of sonorousness. In this fact may be found an explanation of the superiority of light strokes in ascertaining the condition of parts situated directly beneath the points of the chest on which the percussion is made. As a general rule, the average area of dulness in the præcordia, may be stated to be about two inches in diameter, measured transversely by a line passing through the nipple.

The mammary region affords a degree of resonance considerably less than the region situated above it, the infra-clavicular, for reasons other than those already mentioned. The pectoral muscle diminishes the sonorousness; and the difference in the bulk of this muscle, in different persons, is a cause of the differences in the degree of resonance observed in this region within the limits of health. In the female, the mammary gland tends still more to deaden the sound, and in the size of this gland, it is well known different females present a very wide range of difference. It is an error, however, to say that, on this account, the mammary region, in females, "is of no value in percussion."[1] Even when the mamma is unusually large, an abnormal degree or kind of resonance may be determined in this situation sufficiently for the practical objects of diagnosis. In making percussion over the mammary gland, the ivory pleximeter may be used with advantage. With its broad smooth surface the soft parts may be compressed more firmly, and the strokes brought to bear more efficiently on the thoracic walls.

The left mammary region sometimes yields a tympanitic sound on percussion, due to the presence of gas within the stomach.

7. Infra-Mammary Region.—In this region, as well as in the preceding, the two sides naturally present marked disparity as regards percussion-sounds. Over nearly, and in some persons quite, the entire region on the right side, there is absence of sonorousness, owing to the situation of the liver. This fact is not unfrequently overlooked by persons but little accustomed to physical exploration, and the want of resonance attributed to intra-thoracic disease. Instances of this error have often fallen under my observation. The line marking the lower anterior extremity of the right lung, in other words the *line of hepatic flatness*, varies considerably within healthy limits. Determined by percussing downward on a vertical line passing through the nipple (the persons standing or sitting), the point at which resonance ceases, in the majority of instances, will be found over the seventh rib. Not unfrequently, however, it is over the sixth, and occasionally, as low as the eighth rib. Of fourteen examinations made with reference to this point, in nine, hepatic flatness commenced with the seventh rib; in four, with the sixth rib, and in one instance with the eighth rib. The line of hepatic flatness now referred to, is that existing with ordinary respiration. Even with ordinary respiration the line is not fixed, owing to the play of the diaphragm with the two respiratory acts. This may be thus shown: the finger employed as a pleximeter may be placed at a certain point, where, continuing for some time repeated percussions, with some of the strokes a resonance will be observed, and with others none whatever. But forced acts of inspiration and expiration, in consequence of the convexity of the diaphragm with the former, and its depression with the latter act, affect considerably the point at which resonance ceases. If the line of flatness in ordinary respiration be over the sixth rib, the effect of a deep inspiration is to lower it to the seventh rib; and if, in ordinary respiration, the line is on the seventh, it is depressed

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[1] Swett on Diseases of the Chest.

to the eighth rib. In the instance in which the line with ordinary respiration lay on the eighth rib, it was depressed to the ninth. The distance to which it may thus be voluntarily carried downward, is pretty uniformly about 1½ inches. On the other hand, by forced expiration the line of flatness is elevated to an extent less uniform in different persons. It is carried upward to the sixth, fifth, and fourth ribs, the distance varying from 2½ to 5½ inches. The distance from the line of hepatic flatness after a deep inspiration to that after a forced expiration, in different persons, varies from 4 to 7 inches. This distance is a pretty good criterion of the breathing capacity of the individual.

Above the line of flatness, on making forcible percussion, notably diminished vesicular resonance, or well-marked dulness, extends upward for one or two inches. This is caused by the convex upper surface of the liver, covered by the thin extremity of the right lung.

A tympanitic resonance is sometimes but rarely produced by percussing over the liver, due to the presence of gas in the intestinal canal.

In the left infra-mammary region the percussion-sound not only varies in different persons but in the same person at different times; and also in different portions of the region at the same time. These variations depend on the different organs below the diaphragm which encroach on the lower division of the thorax. Into the right portion of the region, the left lobe of the liver extends to an extent somewhat variable, generally, according to Piorry, two inches to the left of the median line. Light percussion over this portion elicits a flat sound, or at all events, absence of vesicular resonance. The left boundary of the liver may generally be defined by the percussion-sound. Beneath the left portion of the region lies the spleen, an organ, the volume of which, as is well known, varies considerably within the limits of health, and in certain diseases (typhoid and intermittent fever), becomes enlarged to a greater or less extent. Frequently, if not generally, the space occupied by this organ, both in health and disease, may be determined by percussion. Its average dimensions, according to the observations of Piorry, are about four inches in length, and three inches in width. The stomach is situated between the two solid organs just named, and this organ is constantly fluctuating as regards degree of distension, and the nature of its contents. Enlarged by the presence of gas, it occasions a tympanitic resonance frequently pervading the whole infra-mammary region, and sometimes extending to the mammary. The sound is characteristic, and may be distinguished as the *gastric tympanitic resonance.* It is high in pitch, and often has a ringing metallic tone. These characters are rendered obvious by contrasting it with the tympanitic resonance elicited by percussion over the intestines. The percussion-sound over the lower part of the left side of the chest is generally more or less modified by the presence of gastric tympanitic resonance. On the other hand, when the stomach is filled with solid or liquid alimentary substances, the percussion-sound is dull or flat.

8. STERNAL REGIONS.—These regions are single; that is, they do not, like the regions already referred to, consist of corresponding divisions of the thorax situated on either side of the mesial line. On this account, and in consequence of the sternum forming a continuous bony covering, devoid of the elasticity belonging to the ribs, emitting an osseous sound when struck, and, moreover, over the greater part of its extent other organs than the lungs lying beneath, it is rarely the case that much important information respecting pulmonary disease is here obtained by means of percussion. Over the greater portion of the upper sternal region, viz., above the lower margin of the second rib, there is more or less sonorousness, which is non-vesicular in character, being due to the air contained in the trachea above the point of bifurcation. From the character of the sound it is sometimes distinguished as *tubular sonorousness*, but for all practical purposes, it suffices to consider it a modification of tympanitic resonance. Below the point of bifurcation, *i. e.* from the second to the lower margin of the third rib, the inner border of the lungs on the two sides approximate, and the resonance may present more or less of the vesicular quality. The remnant of the thymus gland, and the deposit of adipose substance, however, sometimes render the percussion-sound dull or even flat in this situation. The presence of the large vessels leading from the heart conduces to the same result.

Over the lower sternal region, *i. e.* from the lower margin of the third rib, the combination of several different organs occasions various modifications of resonance. Beneath the region are, 1, a portion of the right lung, lying to the right of the mesial line; 2, the greater part of the right ventricle of the heart, and a portion of the left; 3, at the lower part a portion of the liver; and 4, occasionally, where distended, a portion of the stomach. It is obvious that the percussion-sound must vary in different parts of the region, and present often a mixed character. By care and tact in percussion, however, it is practicable frequently, if not generally, to define the boundaries of the several organs which are embraced in a section of this region, by means of the distinctive sounds pertaining to them respectively. This, which, according to Walshe, "is one of the most difficult practical problems in the art of percussion," involves a question of some interest and importance in its bearing on physical exploration, to which reference has not yet been made, and which may be briefly noticed in the present connection. The question is, Do the different solid organs of the body, the liver, heart, spleen, kidney, etc., yield, on percussion, sounds distinctive in character? Piorry, assuming the affirmative of this question to be true, has described a series of sounds, each of which he regarded as characteristic of the organ lying beneath the point percussed. Thus according to him, there is a liver-sound, a spleen-sound, etc., and each of these distinctive sounds is supposed to depend on the molecular arrangement belonging to the structure of the particular organ. The correctness of the opinion just stated is denied by Skoda.[1] According to this author, "there is no difference in the percussion-sound by which we can distinguish between organs not containing air, such as the liver, the spleen, the kidneys, hepatized lung, or lung completely deprived of air by compression, and fluids; a hard liver yields the same sound as a soft liver, a hard spleen as a soft spleen, and blood the same sound as pus, water, etc. We may readily convince ourselves of the fact, by placing these different organs on a non-resonant support, and percussing them one after the other, either with or without a pleximeter; fluids, similarly supported and in sufficient quantity, may also be percussed by aid of a pleximeter, carefully applied to their surface."[2] Walshe makes a similar statement.[3] Others have arrived at an opposite conclusion by means of the very experiments cited by Skoda, and contend that of the different solid organs, and different fluids, each has its peculiar sound, as the wood of various species of trees may be distinguished from each other by percussion, or as bone and cartilage differ in this respect, according to Skoda[4] himself. This point of physics is of less consequence than may at first appear, inasmuch as the question whether the several organs named have not peculiarities of sound *in situ* by no means hinges upon it. Skoda and Walshe do not deny distinction of percussion-sound pertaining to these organs as they are situated in the body, but they account for the difference from the relations of the organs to neighboring parts which contain air, viz., the lungs, stomach, and intestines. The question, therefore, may be settled by the result of examinations practised on living and dead subjects. Facts thus obtained undoubtedly establish the existence of distinctive sounds by which the sites of the different organs may be determined and their boundary lines often mapped out. For example, the sound produced by percussing over the liver differs obviously from that elicited over the heart: the latter is less flat and higher in pitch. It is highly probable that this difference is due to the disparity in size of the two organs, and the parts in juxtaposition, rather than to intrinsic peculiarities of the organs alone. The fact of the difference, however, exists irrespective of the explanation. The peculiarities of sound emanating from solid organs are probably more sharply defined, and appreciated with much greater facility, by employing "*auscultatory percussion*,"[1] than by percussing in the ordinary mode. The practice of ordinary percussion, which is more simple, and therefore more readily available, with a view to determine and mark out the boundaries of the different solid organs encroaching on the chest, is an exercise to be highly recommended, not only as a means of becoming familiar with the characteristic sounds of each, but as tending to impress on the mind the relative situations of these organs, and at the same time, conducing to practical skill in the use of the method of physical exploration under present consideration. To this application of percussion Piorry has given the title of *organographisme*.

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[1] A Treatise on Auscultation and Percussion, by Dr. Joseph Skoda.

[2] Translation, by W. C. Markham, M.D., London edition, page 5.

[3] Op. cit.

[4] See note to French translation of Dr. Skoda's treatise, by the translator, Dr. F. A. Aran, page 6.

9. INFRA-SCAPULAR REGIONS.—Percussion posteriorly, below the scapula, generally yields a marked degree of vesicular resonance. The larger portion of the inferior lobe being embraced in this region, and a very small portion only of this lobe extending into the anterior part of the chest, it is here especially that exploration is made for the physical signs of inflammation of the lungs or pneumonia, the lower lobe being the one affected in the great majority of cases of that disease. The point to which the lower extremity of the pulmonary substance extends is over the eleventh rib. On the right side the line of hepatic flatness commences at or near this point, varying somewhat, as in front, in different persons. This line, as in front, is

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[1] See Essay by Dr. Cammann and Clark, previously referred to.

depressed from one to two inches by a deep inspiration and elevated to a greater or less extent by a forced expiration. Here, too, as in the right infra-mammary region, above the line of flatness in ordinary respiration, a marked degree of dulness on percussion is appreciable for a distance of from one and a half to two inches. On the left side the resonance may be more or less tympanitic, from the presence of gas in the stomach. Below the eleventh rib there may be tympanitic resonance from intestinal gas; and near the spine the limits of the left kidney, which is here situated, may be indicated by the percussion-sound; possibly, also, at the outer side of the lower part of the region, the space occupied by the spleen may in some instances be determinable.

10. Lateral Regions.—The axillary region on both sides is highly sonorous on percussion, the vesicular quality usually being strongly marked. The infra-axillary region generally presents more or less disparity on comparison of the two sides. On the right side, near the sixth or seventh rib, the absence of resonance denotes the line of hepatic flatness, the situation of the line being subject to the same depression and elevation, with inspiration and expiration voluntarily increased, as in front and behind. Dulness for a short distance above this line is also here marked. On the left side the percussion-sound may be more or less deadened by the presence of the spleen; but it is much oftener rendered tympanitic by the presence of gas within the stomach. Crossing the infra-axillary region diagonally is the interlobar fissure, which, although not determinable in health, may be traced by means of percussion in disease (pneumonia), a fact of importance in diagnosis.

Reviewing the regions which have just been considered in connection with the phenomena developed by percussion in a state of health, it will be seen that the following, as regards the intra-thoracic organs embraced within their limits respectively, are nearly similar or symmetrical on the two sides of the chest: *anteriorly*, the supra-clavicular and infra-clavicular regions; *posteriorly*, the scapular and interscapular regions; *laterally*, the axillary region. The remainder, viz., the mammary and infra-mammary, the infra-axillary and the infra-scapular, present anatomical points of dissimilarity attended by a want of correspondence in the physical phenomena produced by the method of exploration under consideration, as well as the other methods remaining to be considered. The regions, however, which in an anatomical point of view are similar, or nearly so, do not invariably, as has been seen, yield identical percussion-sounds, but to a certain extent deviations occur entirely compatible with health. In order to settle with precision, numerically, the ratio of instances in which these variations may be expected to be found, an accumulation of further statistical data is necessary. Moreover, these variations appear in some measure to observe certain laws. Knowledge of the variations, and of the laws by which they are influenced, is important in its bearing on the diagnosis of disease, as will be seen hereafter.

In instituting comparisons of the corresponding regions of the two sides, hitherto, it has been assumed that the chest is free from disparity resulting from deformity or previous disease, in other words, that the two sides are symmetrical in conformation. But instances presenting deviations from anatomical symmetry, as has been seen (Introduction, Sect. I), are of frequent occurrence. In the practice of percussion, and other methods of exploration, it is necessary to take cognizance of the points of dissimilarity which are determined by the method of *inspection*. This is a rule of fundamental importance in physical diagnosis. The most prominent causes of visible alterations in the symmetry of the two sides of the chest, as already stated, are spinal curvature, rachitis, fractures, prolonged pressure on the thorax in infancy, tight lacing, and contraction after chronic pleurisy. The existence or non-existence of alterations from the operation of these or other causes is always to be ascertained, and taken into account in drawing inferences from points of contrast which the physical phenomena pertaining to the two sides may offer.

Allusion has been made to various circumstances occasioning in different healthy persons wide differences in the intensity and other characters of the percussion-sound, viz., the greater volume of the lungs in some individuals than in others; greater elasticity of the thoracic walls; varying amount of muscular development as well as adipose deposit, etc. Age has a certain influence. Other things being equal, in consequence of the greater elasticity of the costal cartilages in early life, the degree of resonance is greater than at a later period, when the cartilages become stiffened, or rigid from ossification. As a general rule, probably, the pitch is lower and the sense of resistance is less in the former case. In old age, the vesicular quality of the resonance is impaired by the atrophied condition of the lung incident to advanced years, and the sound assumes somewhat a tympanitic character.

The percussion-sound may also be found to vary at different periods of an act of respiration in the same individual. The quantity of air contained within the air-cells, and consequently the relative proportion of air and solids, are by no means equal after a full inspiration and after a forced expiration. This difference in lung expansion may occasion an appreciable disparity in resonance, according as the percussion is made at the conclusion of a full inspiration, or a forced expiration. The disparity is not appreciable uniformly in different persons. This fact I have ascertained by noting the results of examinations made with reference to the point. When it does exist, it usually consists, contrary to what might perhaps have been anticipated, and the reverse of what is usually stated in works on physical exploration, in diminished resonance and elevation of pitch at the conclusion of inspiration. This is probably to be explained by the greater degree of tension of the lungs and thoracic walls produced by inspiration voluntarily prolonged and maintained—a condition presenting physical obstacles to sonorous vibrations more than sufficient to counterbalance the increased proportion of air within the cells. It is a curious fact, worthy of notice, that the two sides of the chest are not always found to be affected equally as regards the percussion-sound, at the conclusion of a full inspiration, contrasted with that after a forced expiration. I have observed the contrast to be more striking on the right than on the left side; and in one instance on the left side, the resonance was less intense and somewhat tympanitic after a full inspiration, while on the right side, the opposite effect was produced, and the sound became quite dull after a forced expiration. In view of these variations in a certain proportion of instances incident to different periods of a single act of respiration, in some cases of disease in which it is desirable to observe great delicacy in the correspondence of the two sides, pains should be taken to percuss corresponding points at a similar stage of respiration, and the close of a full inspiration is, perhaps, the period to be preferred. Ordinarily, the liability to error from this source is obviated, either by repeating a series of strokes, first on one side and next on the other, or by percussing both sides repeatedly in quick succession, in order mentally to obtain the average intensity and other characters of the sound during the successive stages of a respiration. The instances of disease, however, are exceedingly rare, in which such nicety of discrimination is important.

Certain rules of manipulation, pertaining to the practice of percussion, have already been stated. Others important to be borne in mind remain to be mentioned. These practical rules are equally applicable to examinations of the chest in health and disease; and it will not, therefore, be necessary to recur to this subject in connection with the morbid signs developed by percussion.

In percussing different portions of the chest it is not a matter of indifference in what position the person examined is placed. To explore the anterior surface of the chest the position most favorable to elicit sonorousness is standing, the shoulders thrown moderately backward, and the back resting against some firm support; next to this is a sitting posture, the back in like manner supported. A recumbent position, although less favorable, is frequently the only one available in cases of disease, owing to the weakness of the patient. In each of these three positions the upper extremities should be equally disposed by the side of the body, the shoulders maintained on the same level, as nearly as possible, and the two sides of the chest on the same plane. Particularly in the recumbent posture, care should be taken that the bed and pillows be so arranged as to avoid any inequality affecting one side more than the other. For an examination of the posterior surface in the most satisfactory manner, the patient must assume a sitting posture, the body inclined a little forward, the arms brought forward, and folded so as to render tense the muscles attached to the scapula. An imperfect exploration, but frequently sufficient for the objects of diagnosis in cases of disease precluding the sitting posture, may be made of the two sides in succession, the patient lying first on one side and then on the other; or it may be practicable sometimes for the patient to rest on the abdomen. In percussing the lateral surfaces, the posture may be standing, sitting, or recumbent, the hands, with the fingers interlocked, resting on the top of the head.

The position of the explorer is also a matter of consequence. If the person examined stand, it is of course necessary to take the same position. If, however, the patient be seated, or recumbent, the examination will be most conveniently made in the sitting posture. It is well to be placed as nearly as possible in front of the mesial line, in order to receive the percussion-sounds from each side of the chest, at an equal distance. If, however, a lateral situation be preferred, or necessary, with reference to the same end, pains should be taken, wherever a delicate comparison is made, to pass from one side to the other, so as to percuss on corresponding points, whilst in a similar relative position to the patient. Identical sounds reaching the ear from unequal distances may appear to differ in intensity, if not in other respects.

The manner in which the strokes are to be made in percussing has been already described. If the finger or fingers of the left hand be the pleximeter employed, they may be placed horizontally on the chest, first on the ribs, and next, in the intercostal spaces; or vertically, at right angles with the ribs. Whenever careful percussion is required, both positions should be resorted to. In percussing the acromial portion of the infra-clavicular region the most convenient disposition is to place the fingers in a diagonal direction. It is better to place the palmar surface of the fingers in apposition to the chest, and strike on the dorsal surface, although the reverse is practised by some who are distinguished in the art of physical exploration.

Percussion is to be made on corresponding points of each side of the chest alternately, care being taken to strike on the ribs, or the intercostal spaces successively, and to compare the sound elicited from the two sides. As already stated, deviations from healthy sounds are determined generally by means of this comparison, and not by reference to any fixed standard. Hence, the differences natural to the chest of different persons do not affect the value of percussion in developing signs of disease. It is therefore important, that the percussion be made in every respect as equally as possible on the two sides. The same degree of force is to be given to the strokes; they are to be made in the same direction, and, in short, so far as practicable, in precisely a similar manner. By the non-observance of due precaution on this point, it is easy to produce a disparity in the percussion-sounds, in cases in which there is in reality no difference as respects the physical conditions on which the sonorousness depends. For example, suppose percussion to be made in the infra-scapular region; and let the strokes on one side be made with the ends of the fingers, in a direction opposite to the spinal column, and the movement favorable for the production of the highest amount of resonance; then, directly afterward, on the other side, let the strokes be made with the pulpy portion of the fingers, in a direction toward the spinal column, and the movement intentionally modified so that the fullest amount of resonance shall not be produced, the disparity between the two sides will be marked, and yet, if such an experiment be not watched by a critical observer, the difference in the mode of percussing will not be detected. A difference in simply the force of percussion on one side, in any situation, while the muscular effort appears to be similar, and in all other respects the blows are identical, will suffice to occasion an obvious disparity in sound. Hence, before deciding on the actual existence of a slight disparity, percussion should not only be made with great care, but repeated often enough to obviate the liability to deception by a failure to strike with equal force on corresponding points.

That the eye may select points which correspond on the two sides, and the better to secure uniformity in the act of percussing, it is preferable, in cases in which nicety of discrimination is required, to divest the chest of all covering. In the female, this is opposed by a regard for delicacy. The end may, however, be attained without offending propriety by uncovering portions of the chest at a time, and not exposing the mammæ, which is rarely if ever necessary. In many instances the objects of physical exploration may be accomplished without the necessity of denuding any portion of the chest.

In addition to the sounds produced by percussion, important information may sometimes, at the same time, be obtained by directing attention to the *sense of resistance*, felt by the fingers when struck. In proportion as the walls of the chest are deprived of their elasticity, or the parts contained within the thorax are unyielding to pressure, a sense of resistance will be appreciable by the finger on which percussion is made. In the healthy chest this is rendered very apparent by percussing in the right infra-mammary region, where hepatic flatness exists, and contrasting the resistance with that felt in percussing either at the upper part of the chest on the same side, or on the lower portion of the left side of the chest. A disparity in this respect between corresponding points in which an equality should naturally exist, becomes a physical sign of disease.

Finally, the following rule may be repeated, viz., to ascertain the physical condition of the superficial portion of the intra-thoracic organs, the percussion-blows should be light; but to determine a disparity dependent on deep-seated alterations, forcible percussion is requisite. In connection with this rule, it is to be stated that ordinarily in the practice of percussion, delicate strokes, which do not occasion pain, nor present an appearance of roughness, answer every practical purpose.

The facts and rules which have thus been given under the head of Percussion in Health are commended to the attentive consideration of the student before entering on the study of Percussion in Disease.

After becoming familiar with all that has already been presented relative to percussion, and practically expert by resorting to examinations of healthy chests, the knowledge of the morbid signs developed by this method, and its application in the diagnosis of thoracic affections, are easily attained. In fact, to so great an extent may the physical phenomena of disease be studied in health, that, after, such a preparation, the subject offers no difficulties.

Percussion in Disease.

The various physical changes incident to disease affecting the intra-thoracic organs occasion corresponding modifications of the sound elicited by percussion, and hence, the latter become the *signs* of the former. The more important of the physical changes incident to different forms of disease, are the following: over-distension of the pulmonary vesicles, involving usually abnormal expansion of the chest, and a greater degree of tension than belongs to health; undue reduction in the quantity of air, associated with more or less increased density of lung, from the deposits of effused blood, serum, coagulable lymph, tuberculous or other morbid products; the presence of air or liquid, or both, in excavations or cavities, formed at the expense of the pulmonary substance; liquid of different kinds in the pleural sac, compressing the lung, and sometimes supplanting it entirely; and air or gas contained between the surfaces of the pleuræ, generally with, at the same time, a greater or less proportion of liquid. Certain physical phenomena, ascertained by percussion, as well as the other methods of exploration, are found by clinical observation to accompany the foregoing morbid conditions, and on the constancy of the connection between these phenomena and morbid conditions, establishing the relation of cause and effect, depend the significance and value of the former as indices of the latter. Resonance of the healthy chest, has been seen to involve the following elements, viz., a certain amount of intensity, or loudness; a peculiar quality or timbre, characterized as pulmonary or vesicular; pitch, and duration. Morbid deviations from healthy resonance are to be analyzed, and studied under the same general aspects. It is by attention to these different qualities that the signs developed by percussion are recognized, and discriminated from each other. Abnormal sounds, then, we repeat, are distinguished from healthy resonance, and from each other, by variations in intensity, in quality, in pitch, and in duration.

Proceeding to a description of the physical signs of disease developed by percussion, the question at once arises, what arrangements and what terms shall be adopted? Authors differ upon this point. The following classification appears to me sufficiently comprehensive and minute for practical purposes.

1. *Exaggerated Vesicular Resonance.*—The term *clear* is usually employed to express both normal and undue intensity of sonorousness. The term is confessedly inappropriate, inasmuch as, strictly, it expresses not intensity, but purity of sound; but the application is sanctioned by usage. *Clearness* of resonance, however, is an expression equally applied to instances in which the character of sound is changed. To observe precision, therefore, it is necessary to qualify it as *vesicular*, when the resonance retains the peculiar quality indicated by that title. It were better to dispense with the term and designate the sound proper to health as *normal resonance*, and a sound increased beyond the limits of health, but not essentially changed in other respects, as *exaggerated vesicular resonance.* This will be the designation of the first of the heads under which the physical signs furnished by percussion are to be distributed. 2. *Diminished Vesicular Resonance.*—Diminution of resonance, as a sign of disease, is usually called *dulness.* A dull percussion-sound generally differs from the normal resonance, at the same time, in quality, pitch, and duration. This will constitute the second division. 3. *Absence of Resonance*, commonly known as *flatness.* The type of this sound is that produced when the thigh is percussed. This will make a third division. 4. *Tympanitic Resonance.*—Under this division I embrace all varieties of sonorousness in which the vesicular quality is wanting. It will include the varieties called by some tubular, amphoric, and the cracked metal sound (*bruit de pot fêlé*). Tympanitic resonance usually presents deviations from that of health not only in quality but in intensity, pitch, and duration.

Of the foregoing divisions it is perceived that the three first are based on deviations in the *intensity* of sound, the names denoting distinctions in this character and none other; while the last division is founded on a change in the *quality* of sound. Deviations in *pitch* and *duration* of sound are important, but there is no necessity for constituting separate divisions based thereon, since, with few if any exceptions, they are always associated with changes in intensity or quality.

It suffices, therefore, and simplifies the subject, to consider the characters of morbid percussion-sounds which are derived from the attributes just named, viz., pitch and duration, as incidental to the several classes embraced in the above arrangement. It seems to me that all the sounds developed by percussion in disease admit of being resolved into four divisions, according to this arrangement, considering variations not expressed by the terms of the classification in the light of incidental characters. Other classes, however, are mentioned by some authors: Skoda, for example, distinguishes certain sounds, as either *empty* or *full*. By these terms he intends to express certain differences conveyed to the ear by the character of sound as to the size of the space in which it is produced, or in other words, the extent of its diffusion. He illustrates the distinction thus: "We do not judge of the size of a resonant body by the strength of the sound which strikes upon the ear; the slightest vibration of a large bell tells of its magnitude; the loudest ringing of a little bell misleads no one as to its smallness; neither do we judge of the dimensions of bodies, from the pitch of their sounds."[1] To make this the basis of a distinct class of sounds seems to me an over-refinement, tending to complicate the subject, and thereby discourage the student. The reality of the distinction, however, may be admitted, and differences in this respect considered, like diversities in pitch and duration, incidental to the sounds arranged in the several divisions that have been adopted. The terms fulness and emptiness are unfortunate, not expressing, except constructively, the meaning attached to them by the translator of Skoda's treatise; but it would be difficult to fix on other terms which express the distinction more satisfactorily.

It remains to consider the phenomena falling under the foregoing classes severally, and their relations to the different morbid conditions of which they are the signs.

1. EXAGGERATED VESICULAR RESONANCE.—Increased resonance, *the vesicular quality of sound being preserved*, is chiefly important as a sign of a single morbid condition, viz., abnormal accumulation of air in the pulmonary cells, constituting pulmonary or vesicular emphysema. The physical change in the lung in this affection renders the fact of an increased sonorousness sufficiently intelligible. The amount of resonance proper to health depends on the presence of air in a certain proportion to the solid parts. When, from disease,

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[1] Op. cit.

the quantity of air is increased, the solid parts remaining the same, or even diminished by the atrophy which may accompany emphysema, a greater intensity of the percussion-sound would be looked for. Associated with signs developed by other methods of exploration, this is quite distinctive of emphysema. With the exaggerated resonance the vesicular quality is preserved. This fact distinguishes it from the increased sonorousness due to another and quite different affection, viz., pneumothorax, in which an abnormal clearness exists, without the vesicular quality, in other words with tympanitic resonance. In emphysematous distension of lung, however, the vesicular quality of resonance, although preserved, is more or less diminished, and in proportion as it loses this quality it acquires a tympanitic character: this, *à priori*, would be expected. Moreover, the increase in sonorousness is not proportionate to the degree of enlargement or distension of the air-cells. This interesting fact has been pointed out particularly by Skoda. If the lung become highly emphysematous, and the chest considerably expanded in consequence of the greater volume which the lung acquires, instead of being remarkably sonorous the chest may even yield on percussion a dull sound, and under these circumstances the vesicular quality is proportionally less marked. This fact is probably due mainly to the extreme tension of the pulmonary organs and the thoracic parietes.

In proportion as exaggerated vesicular resonance preserves the vesicular quality, it may probably be stated as a general rule that the percussion-sound is long in duration and low in pitch. Conversely in proportion as it loses this quality, and becomes tympanitic in character, it is shorter and higher in pitch.

In determining the existence of exaggerated vesicular resonance we should be at a loss in cases in which both lungs are equally affected by emphysema, were we not aided by signs developed by other methods than percussion, and also by symptoms; because we have no fixed standard of natural resonance, and there are wide differences in different persons in this particular. The evidence afforded by percussion alone is much more complete when the affection is limited to one side, or exists to a greater extent on one side than on the other, which is usually the case. Under these circumstances we have the advantage of a comparison of the two sides. It is needless to add that the natural resonance of different regions on the same side differing considerably in health, it is necessary here, as in other instances, to institute a comparison between corresponding situations on the two sides. In one situation, however, the effect of emphysema is to render more equal corresponding regions in which there is a disparity in health; reference is had to the mammary region. The præcordia is naturally dull in consequence of the presence of the heart, which the lung does not completely overlay. But if the left lung become highly emphysematous, the heart is fully covered and removed from the thoracic walls, so that the percussion-sound is abnormally clear in that situation, and it may require forcible percussion to discover a disparity between the two sides.

Guided by percussion, alone, in cases in which the vesicular resonance is greater on one side than on the other, there would be a liability to err in attributing this apparently increased sonorousness to emphysema, when, in fact, it is simply the normal resonance, but relatively greater in consequence of disease seated in the other side, which diminishes the resonance on that side. This error is avoided by resorting to other signs pointing to the side affected.

As already stated, exaggerated vesicular resonance is chiefly valuable as a sign of emphysema. It is altogether probable that when the lung of one side becomes hypertrophied, in other words, acquires an increased expansion in consequence of the lung on the other side being rendered useless by disease, as in cases of chronic pleurisy, the degree of resonance exceeds that belonging to health. It is difficult to determine this fact positively, unless we chance to know the amount of resonance peculiar to the individual before he was attacked with the disease, because we lose the resonance of the diseased side as a standard for comparison. The point, however, possesses little or no importance in diagnosis.

The sonorousness of the chest, becomes, of course, greater in proportion as the coverings of the thoracic walls are attenuated in the progress of diseases attended by emaciation. But under these circumstances both sides are equally affected; this, in connection with the absence of other signs, suffices to exclude pulmonary disease.

2. Diminished Resonance, or Dulness.—As a sign of disease resonance is much oftener lessened than augmented. Indeed, this is the change which occurs in the vast majority of pulmonary affections. The morbid conditions which occasion it are quite numerous. Under this division, it should be premised, are embraced the instances in which the resonance is less than normal, without being completely abolished, and the diminution may have every possible degree of gradation

from the sonorousness of health, to a point at which resonance ceases. The sound is *dull* until this point is reached, when it becomes *flat.*

Normal resonance is impaired, whenever, from any morbid cause, solids or liquids occupy space within the chest at the expense of the normal quantity of air in the vesicles. This occurs in a variety of diseases, the more important of which are as follows:

a. In some rare instances a disproportion between the solid structures and the air takes place as the result of the reduction in the quantity of the latter, the former not being increased. An obstruction may exist from the presence of a morbid product or a foreign body within the bronchial tubes, which resists the ingress of air to the cells with inspiration, but permits its egress with expiration. Collapse of more or less of the pulmonary lobules, under these circumstances, may follow. The effect on the percussion-sound is to diminish the normal resonance, which depends, *cæteris paribus*, on the quantity of air contained in the pulmonary vesicles. In the vast majority of cases, however, this effect is due to the increase of the solid contents of the chest, which occupy space to the exclusion of air.

b. A thin stratum of liquid between the pleural surfaces, serum, or serum and coagulable lymph, in hydrothorax and pleurisy, may occasion more or less dulness on percussion. This is an infrequent cause, the quantity of liquid effusion and fibrinous exudation generally being so disposed, and in sufficient quantity, to occasion total loss of resonance, or flatness, over a greater or less distance from the base of the chest upward. Instances, however, may occur, in which, from adhesions of the pleural surfaces, a small quantity of these products may be confined within circumscribed limits, removing the lungs from the walls of the chest sufficiently to diminish but not destroy vesicular resonance.

In cases in which a considerable quantity of liquid is contained within the pleural sac, the lung, of necessity, undergoes compression and condensation. Over the portion of the chest beneath which the condensed lung lies, the *vesicular* resonance is diminished, the reduction of the lung in volume increasing the proportion of solids to the quantity of air within the cells. At the summit of the chest, therefore, the percussion-sound is usually dull. But under these circumstances a sonorousness frequently exists, modified in quality, which will be noticed under the head of Tympanitic Resonance.

c. A very large accumulation of morbid products within the bronchial tubes may be attended by slight dulness. This also is extremely rare. Unless the quantity be so great as not only to fill the tubes, but to distend them, and thus encroach upon the air-cells, the resonance on percussion is not appreciably lessened; hence, as will be seen hereafter, in cases of bronchitis attended with very abundant expectoration, the normal resonance is not sensibly impaired. Skoda denies that appreciable dulness ever exists in cases of bronchitis. This assertion is too positive, and does not accord with the observations of others.

d. Congestion of the pulmonary vessels may exist to such an extent that the blood, occupying space at the expense of the normal capacity of the air-cells, the resonance is diminished. Moderate or even considerable congestion does not produce this effect. The engorgement must be great; a sufficient degree obtains in some cases at least of pneumonitis, during the first stage, or stage of engorgement,[1] and in the hypostatic congestion of the dependent portion of the lungs taking place towards the close of life in various diseases.

e. The exudation of coagulable lymph within the air-cells which characterizes the second stage of pneumonitis, or the stage of solidification, occasions notable dulness. Here the cells themselves are to a greater or less extent filled with solid matter, supplanting, in proportion to its abundance, the air. The dulness will, *cæteris paribus*, be proportionate to the quantity of exudation, occasionally merging into complete flatness. Certain circumstances distinctive of the solidification of the lung, which occurs in the form of pneumonitis usually presented in the adult, viz., lobar pneumonitis, will be noticed under the head of Absence of Resonance or Dulness.

f. Effusion of serum within the air-vesicles and areolar tissue of the lungs, is another morbid condition attended by dulness, and in some instances flatness. This condition, never a primitive affection, but generally incident, when it takes place, to disease of heart inducing pulmonary congestion, is to be included among the infrequent causes of diminished resonance.

g. Deposit of tuberculous matter within the cells is the most frequent in its occurrence of the morbid conditions characterized by the change in the percussion-sound under consideration. The mode in which it occasions diminished resonance is the same as in pneumonitis.

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[1] This appears to be denied by Skoda; and since death rarely occurs from pneumonitis during the stage of engorgement, opportunities to demonstrate the correctness of the statement which has been made are not often obtained. In a case under my observation, in which a patient died with enormous dilatation of the heart shortly after an attack of pneumonitis, the limits of the lower lobe of the right lung had been marked on the chest by a line of obvious dulness on percussion; and this lobe after death was found in the first stage of inflammation, no solid exudation having taken place. (Hospital Record for April, 1855, cases of Peterson.) The denial by Skoda is not in accordance with the observations of others.

h. Carcinomatous infiltration of the pulmonary parenchyma, fortunately extremely rare, will occasion dulness, in the same manner as tuberculous matter.

i. Extravasation of blood, constituting pulmonary apoplexy, is another rare form of disease, producing the same effect in the same way.

k. Tumors, morbid growths, aneurisms, and enlarged bronchial glands, are occasional forms of disease, which, according to the extent of encroachment on the thoracic space, lead either to diminution or absence of vesicular resonance.

In each and all of these various affections, percussion alone developes nothing beyond the simple fact of the existence of some physical alteration preceding dulness. It affords no information in particular cases, as to which one of the different morbid conditions exists. To determine this point the co-operation of other methods of exploration is requisite, taken in connection with symptoms, and the known laws of diseases. In certain instances, however, the situation of the dulness, irrespective of other signs, or of symptoms, is a sufficient ground for a strong presumption as to the nature of the disease. If the dulness extend over the space occupied by the lower lobe, especially of the right lung, it probably arises from pneumonitis, this affection being seated, in the great majority of cases, in the lower lobe, oftener of the right than the left side. If, on the other hand, the dulness exists at the summit of the chest on one side, the chances are greatly in favor of its proceeding from a tuberculous deposit, in view of the frequency of that disease, taken in connection with the fact that the deposit first takes place, almost invariably, at or near the apex of the lung on one side. But it is rarely, if ever, necessary to rely on the evidence afforded by one only of the methods of exploration, or to depend on signs to the exclusion of symptoms. And it is one of the great advantages pertaining to physical diagnosis that phenomena developed by different modes of examination may be brought together, mutually serving to supply deficiencies, correct liabilities to error, and combining to render positive the conclusions therefrom educed.

Incidental to *diminished vesicular resonance* are certain deviations relating to pitch, duration of sound, and the sense of resistance. As a general rule, when the solid contents of the chest are increased at the expense of air within the cells, whatever may be the form of disease involving this physical change,not only is the vesicular resonance diminished, but the pitch of the percussion-sound is raised, the sound is shortened in duration, and the sense of resistance is increased. These four deviations generally go together, viz., diminished resonance, elevation of pitch, shortened duration, and greater resistance. This rule is important to be borne in mind in the practice of percussion. A dull vesicular sound, contrasted with a clear vesicular sound, is at the same time higher in pitch, less in duration, and the sense of resistance is greater. In the several forms of disease, therefore, which have been enumerated, these changes are united.

A point highly important to be understood in connection with this subject is, that *vesicular* resonance may be diminished or abolished, not involving a corresponding loss, but even with an increased degree of sonorousness: that is, sonorousness may exist to an extent equal to that in health and even greater, but without the vesicular quality, the resonance, in other words, being more or less tympanitic. In the majority of instances in which the solid contents of the chest are increased at the expense of the air in the vesicles, it is probably true that the percussion-sound becomes proportionately *dull* in every sense, using this term with its ordinary acceptation; but in a certain ratio of cases it is otherwise. The vesicular resonance is diminished, but in this sense only the sound is dull. The vesicular quality is replaced by a sonorousness, it may be exceeding the normal intensity, and approximating more or less to a tympanitic resonance. Hence, in cases of compression of lung from pleuritic effusion, as already stated, and also in solidification from tuberculous deposit or inflammatory products, percussion sometimes elicits an exaggerated tympanitic sound. This point will be considered under the head of Tympanitic Resonance. The fact just stated obviously has an important bearing on the subject under present consideration. The proportion of instances of the forms of disease just referred to, in which the fact exists, remains to be settled by numerical observations.

Diminished vesicular resonance, with or without tympanitic sonorousness, in the different forms of disease thus characterized, is ascertained by contrasting the two sides of the chest; for fortunately the laws governing pulmonary affections do not conflict with making one side a standard of comparison by which to estimate the deviations from health on the other side. With very few exceptions, in cases of pulmonary diseases, attended by alterations in the healthy resonance on percussion, either the affection is confined to one side, or is more advanced on one side than on the other. This would almost seem to be an express provision for facility of diagnosis. In by far the greater proportion of cases occurring in practice, in which the resonance on one side is diminished from a morbid cause, the fact is determined without difficulty. The disparity between corresponding points on the two sides is sufficiently obvious to be easily recognized. Occasionally, a delicate comparison is necessary. This is sometimes the case in the early stage of phthisis, when the morbid deposit is in the form of small disseminated tubercles. To appreciate a slight difference which may be significant of the small physical change, that has as yet taken place, observing all the precautions that have been pointed out, and repeating on corresponding points at the summit of the chest, a succession of strokes as equal in every respect as possible, the sound elicited on the two sides is to be compared as respects intensity, vesicular quality, pitch, and duration. My observations have led me to regard attention to pitch, as particularly useful, in cases in which delicacy of discrimination is required.[1] A variation in pitch by one who has what is called a "musical ear," is more easily recognized, than a slight disparity in the amount of resonance; and in some instances the former may be distinguishable without difficulty, when the latter is inappreciable. In cases, therefore, of suspected tuberculosis, it is important to compare the sounds on the two sides as if they were musical notes, in order to determine whether they are in unison, or differ in their diatonic relation to each other. A difference in pitch may then be the only discoverable evidence of dissimilarity, and, in connection with other signs and symptoms, may be entitled to considerable weight in the diagnosis.[2] The importance of attention to the pitch of percussion-sounds with a view to greater nicety and accuracy of discrimination, seems to me not to have been sufficiently appreciated by most writers on the subject of physical exploration. A late writer, indeed, whose views have attracted much attention, declares that variations in this respect are of little value in practice.[3] It is worthy of remark, that in the classification of percussion-sounds by Auenbrugger, variations in this respect occupied the first rank, although with reference to this point, he was misapprehended by his translator and commentator Corvisart,[1] a fact which may perhaps serve to account for its having been subsequently overlooked by others.[2]

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[1] See Prize Essay by author.

[2] This is probably true of the exceptional cases, to be referred to again under another head, in which the percussion-sound over the site of tubercles has a greater degree of sonorousness than belongs to health. See under head of Tympanitic Resonance.

[3] Skoda.

In estimating the diagnostic value of a slight disparity in the sounds elicited by percussion on the summit of the chest, the fact that in but a small proportion of instances is there perfect correspondence in persons presumed to be in perfect health, and whose chests do not exhibit any apparent deviation from symmetry, is to be borne in mind. The rule found by observation to govern the differences compatible with health and good conformation, also has a very important practical bearing in diagnosis, viz., in the great majority of instances in which such differences exist, slight dulness, or elevation of pitch, is found on the right side. From this fact it follows that dulness, or elevation of pitch, situated on the right side, are very likely to be due to a natural disparity between the two sides; but situated on the left side, it probably proceeds from a morbid condition.

In instituting a very close comparison, as already remarked, care should be taken to make percussion on each side when the chest is equally expanded. This is to be done by requesting the patient to hold his breath after a full or moderate inspiration, until the comparison is made. It is stated[3] that in some cases of slight solidification from disseminated tubercles, the two sides may present a marked difference in the contrast between the sound elicited on the same side by percussing first after a full inspiration, and next after a forced expiration. The pathological significance of a disparity in this respect is impaired by the fact that it is sometimes observed in examinations of the healthy chest.

In every instance in which a slight disparity between the two sides of the chest is discovered, before concluding it to be a sign of present disease, it is to be ascertained whether it be not due to a want of symmetry in conformation, which may be so slight as to escape observation unless attention be directed to the point. Important errors will be likely to be committed without the observance of this precaution.

3. Absence of Resonance, or Flatness.—Complete abolition of sonorousness is incident to certain abnormal conditions. The effect

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[1] Notes to French edition of Skoda by the translator, Dr. Aran.

[2] The importance of attention to variations of pitch in the diagnosis of certain cases of phthisis is emphatically dwelt upon by Dr. Bowditch in his work entitled "The Young Stethoscopist."

[3] Dr. Walshe and Dr. J. Hughes Bennett.

of percussion is the same as when the thigh is struck. The sound is said to be *flat.* Perfect flatness on percussion obtains especially when the pleural sac is filled with liquid effusion, either serum, serum and lymph, or pus. If the lung or an entire lobe be completely solidified by the exudation of lymph, or infiltrated tuberculous matter, there may be flatness, but it is rarely the case that sonorousness is so completely extinct as in the former instance. The presence of a small quantity of air in the bronchial tubes, and the proximity of the solidified portion (if the whole lung be not solidified) to another portion in which the vesicles contain air, occasion a slight degree of resonance, although perhaps so extremely slight as not to be appreciable without comparison with the effect of percussion on a part which is absolutely flat. A large tumor within the chest may occasion flatness.

In cases in which flatness, or a degree of dulness closely approximating thereto, exists over a portion of the chest, the discrimination lies between liquid effusion, solidification of lung, and morbid growth. It follows from the statement just made, that the degree of flatness, or, more correctly, the existence or not of positive flatness, as distinguished from dulness, enters into this discrimination. Displacement of the lung by the accumulation of liquid, or a solid tumor, may occasion absence of all resonance, while over lung, be it ever so completely solidified, there is usually only an extreme of dulness. But in making this discrimination, important information is derived from the situation of the flatness, and, in certain cases, the effect of variations in the position of the patient. If the flatness be situated at the superior portion of the chest, the probabilities are vastly opposed to its being due to the presence of liquid, for, excepting in some instances, which must be exceedingly rare, in which liquid effusion is confined to the upper part by adhesion of the pleural surfaces below, it will fall to the bottom of the sac, and the flatness will extend upward for a distance proportionate to the amount of the effusion. The extreme dulness, or possibly absolute flatness, due to solidification of the lower lobe in pneumonitis, may be ascertained by delineating on the chest its upper boundary, and finding that the line pursues the direction of the interlobar fissure. This is a point pertaining to the physical diagnosis of pneumonitis, to which writers on the subject have not sufficiently adverted. Moreover, the limits of the flatness or dulness incident to that disease, remains unaltered in every position of the patient. The same remark will apply to tumors, unless, as may happen, and an instance is given by Walshe, they are not attached except by a small pedicle. But in a certain proportion of cases in which liquid is contained within the pleural sac, the level of the surface of the liquid varies with different positions of the body, and may be ascertained without difficulty by percussion. If the level be ascertained by determining the line of flatness, and marked on the chest when the body of the patient is in an upright position, it will be found to encircle the chest nearly in a horizontal direction, the liquid obeying the same law of gravity within the chest, as if it were contained in a vessel out of the body. If now the patient take a recumbent posture, the level of the liquid in front will be found to have descended, and a line denoting the upper boundary of the flatness, pursues from this point a diagonal direction intersecting obliquely the horizontal line previously made. Or, without taking pains to demonstrate the variation of level so elaborately, which is not always convenient in practice; let the upper limit of the flatness in front be ascertained by percussion, while the trunk is in a vertical position; then cause the patient to lie down, and ascertain if the resonance do not extend an inch or more below the point at which, in the previous position, the upper limit of flatness was found to exist. A few ounces of fluid in the pleural cavity may, in some instances, be detected in the manner just described. The physical explanation of these changes is sufficiently obvious. This mode of determining, by percussion, the presence of liquid is not applicable to all cases, but only to those in which the quantity is not so great as to fill the pleural sac, compressing the lung into a small space, and to those in which the movement of the liquid is not prevented by adhesions of the pleural surfaces. Both these conditions are apt to be wanting in pleurisy, and hence the test is less frequently available in that affection than in hydrothorax. The discrimination, however, of flatness occasioned by liquid effusion, from that which may be due to solidification of lung, does not depend exclusively on the evidence obtained by percussion. The physical signs derived from other methods of exploration, combined with those afforded by percussion, generally warrant a positive diagnosis. The employment of percussion after the rules just given enables the practitioner to determine from day to day, or from week to week, the changes which take place in the quantity of liquid effusion. The progress of the disease and the effects of remedies may thus be accurately observed. This is a practical consideration of no small importance. With a view to note the increase or diminution of the fluid, the line of flatness, denoting the level of the liquid, while the body is in a vertical position, may be permanently marked on the chest by means of a stick of the nitrate of silver. The series of lines thus made during the course of pleurisy or hydrothorax, form a kind of diagram illustrating its past history.

The physical conditions producing absence of resonance, or flatness, occasion at the same time, and usually in a notable degree, a sense of increased resistance; in other words, the ribs are less yielding to pressure from without. This sign, *cæteris paribus*, will be marked in proportion to the elasticity of the costal cartilages, and hence be more obvious in early life than after the thoracic walls become unyielding from the stiffening and ossification incident to advanced years.

4. TYMPANITIC RESONANCE.—Agreeably to the definition already given, under this head are embraced all kinds of sonorousness which want the special quality or timbre characteristic of the presence of air in cells, which has been distinguished as *vesicular resonance.* The name implies a drum-like sound, and the type is the sound emitted by the tympanitic abdomen. It is proper to state that the expression is not generally used in a sense so comprehensive. By some writers[1] it is limited to exaggerated pulmonary or vesicular resonance. With the French it is considered to denote a clear, intense sound, without necessarily having any special quality or timbre.[2] It seems appropriate, and simplifies the subject, to call the different percussion-sounds tympanitic, which, however they may differ among themselves, agree in this, viz., that they are non-vesicular. The distinctive feature, then, of tympanitic resonance pertains to its quality or timbre. It may have any degree of intensity so long as it possesses the negative distinction just named. It may be louder or clearer than the normal resonance, or, on the other hand, a sound ever so dull, which is not flat, may be tympanitic.[3] It presents under different circumstances striking modifications, which are practically not unimportant, but it suffices to consider them as constituting different varieties of tympanitic resonance.

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[1] Walshe, first edition.

[2] Dr. Henri Roger, Archives générales de médecine, 1852.

[3] Dr. Stokes makes a statement similar to this. Speaking of the difference between the resonance on the left side from the presence of gas in the stomach and that from pneumothorax, he says, "I might say, and stethoscopists will appreciate the distinction, that the one is a tympanitic dulness, the other a tympanitic clearness." Diseases of the Chest, 2d Am. edition, 1844, page 284.

It has been necessary already to refer to the tympanitic quality of percussion-sounds. The exaggerated resonance of emphysema acquires a tympanitic character, but without losing entirely the vesicular quality.[1] When the tension is great, in some cases of emphysema, the sonorousness diminishes, as has been stated already, and the sound is then said by Skoda to be non-tympanitic. But by this expression is meant simply that the loudness and clearness are diminished. Using the term tympanitic as applied to an altered quality of sound, the statement by Skoda is incorrect, inasmuch as with the diminution of sonorousness under these circumstances the vesicular quality is not increased. The tympanitic quality may be combined in every proportion with the vesicular quality of resonance. In percussing the chests of different persons in health, there will be found to be marked differences as respects the predominance of one or the other. As a general rule, if not invariably, it may be stated that in proportion as a percussion-sound approximates to tympanitic resonance, either in health or disease, the pitch is raised. Finally, over different portions of the chest in the same individual the resonance differs in this respect. In the lower part of the infra-clavicular region, for example, the vesicular quality is marked; while over the scapula it is much less so, showing that this peculiar quality is not altogether independent of the thoracic walls. Frequently over the lower part of the left side, in front, and laterally, and occasionally over the lower part of the right side, the resonance is notably tympanitic, in the former situation from the presence of gas in the stomach, and in the latter from flatulent distension of the colon.

Tympanitic resonance occurs in different forms of disease, and presents certain modifications, which, to some extent, are significant of particular morbid conditions. These modifications, which may be considered as forming several varieties of this division of percussion-sounds, will be noticed in connection with the different affections giving rise to the quality of resonance under consideration.

Existing in a marked degree of intensity, exceeding that of normal resonance, and generally even the exaggerated resonance of emphysema, it becomes, combined with other circumstances, a sign quite distinctive of the presence of air or gas in considerable quantity within the pleural sac. This physical condition characterizes the disease called *pneumothorax*, or as air and liquid are usually combined in variable proportions, *pneumo-hydrothorax*. In this affection percussion of those portions of chest situated over the space occupied by air, elicits a loud sonorousness totally devoid of vesicular quality and which gives to the mind an impression of a hollow space of considerable size filled with air. So far as an idea of size is conveyed, it is what Skoda calls a *full*, in distinction from an *empty* sound. An interesting fact pertaining to the sound occurring as a sign of pneumo-hydrothorax has been pointed out by the author just named. When the chest is greatly distended by the large accumulation of liquid and air, the degree of sonorousness is less than when the distension is but moderate. The sound may even become dull. It is stated by Skoda that it becomes non-tympanitic. It is not, however, to be understood by this expression that it acquires the vesicular quality of resonance, although the normal resonance of the chest is cited by Skoda as the type of a non-tympanitic sound. It is evident that the quality of resonance must remain tympanitic under these circumstances. It is meant only that it loses its intensity. This fact is probably due to the extreme tension of the thoracic walls. A similar phenomenon, as remarked by Walshe, is observed in a drum. "If a drum be tightened to the extreme point possible, and all escape of air from its cavity prevented, its sound, when struck, becomes muffled, toneless, almost null."

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[1] Were it not so desirable as it is to avoid creating distinctions and multiplying names more than is practically essential, I should propose to distinguish a percussion-sound-partly tympanitic and in part vesicular, and apply to it the title of *vesiculo-tympanitic resonance*. I have found this expression convenient in making clinical notes.

The tympanitic resonance in pneumo-hydrothorax sometimes has a ringing metallic tone, resembling the sound produced by tapping lightly the back of the hand when the palm is applied firmly over the ear. This character of resonance is more apparent if percussion be made while the ear is applied to the chest.

The presence of liquid effusion in cases of pneumo-hydrothorax, gives rise to flatness on percussion below the inferior boundary of tympanitic resonance, and the relative portions of the surface of the chest over which resonance or flatness are found, will serve to determine the relative quantities of liquid and air. If the pleural surfaces are free from adhesions, the tympanitic resonance will, of course, exist at the superior portion of the chest, the body being in a vertical position. But inasmuch as pneumo-hydrothorax occurs oftener as an accidental complication of phthisis than otherwise, and since, in the latter affection adhesions generally take place to a greater or less extent, the air may be prevented from distending the upper part of the pleural sac.

Under these circumstances, there may be a liability of attributing the tympanitic sonorousness due to air between the pleural surfaces, to the presence of gas within the stomach. The situation of the space occupied by air will be found to vary with the position of the patient. Thus, if when the trunk is inclined far backward the dimensions of the surface corresponding to the tympanitic resonance be marked on the chest in front, they will be considerably lessened by repeating the examination when the trunk is inclined far forward. The same is true, of course, of the posterior surface. The level of the surface of the liquid may be ascertained as in ordinary pleurisy, or in hydrothorax, and this will be found to vary with different attitudes, obeying the same rules as in the diseases just named.

The diagnosis of pneumo-hydrothorax does not rest exclusively on percussion, although the evidence afforded by this method is generally in itself quite conclusive. With an imperfect knowledge of the subject, however, there are liabilities to deception. Emphysema, as has been seen, is attended not only by exaggerated sonorousness, but a quality of resonance approximating to the tympanitic. It does not, however, lose entirely the vesicular quality. It is unaccompanied by the physical signs of liquid effusion, and is distinguished by signs obtained by other methods. The whole of the left side is sometimes rendered highly tympanitic by distension of the stomach with gas. In such instances, aside from the distinctive circumstances which are not less applicable than in emphysema, the intensity of the tympanitic resonance is greatest at the lower part of the chest; and diminishes in proportion as percussion is made toward the summit, thus reversing the rule which obtains in pneumo-hydrothorax.

A condition more likely to lead into error is ordinary pleurisy, attended, as is not unfrequently the case, by a tympanitic resonance, more or less strongly marked, above the level of the liquid, on the surface beneath which is situated the compressed lung. For the knowledge of this important as well as interesting fact, to which allusion has already been made, we are mainly indebted to Skoda. He is entitled to the credit of having pointed out the frequent occurrence of increased and tympanitic sonorousness over the chest, above the line of flatness denoting the height to which the liquid rises.

This subject has also been investigated by Dr. Henri Roger of Paris.[1] The latter observer found, that of 51 cases of pleurisy, 41 were characterized by this feature. In these cases the increased tympanitic resonance was not constantly present, but existed for a greater or less period during the progress of the disease. The fact of the occurrence of this feature was not altogether novel. It had been observed by Dr. Williams. I had noted it as present, in a marked degree, in two cases of chronic pleurisy which came under my observation several years ago.[1] In the discovery of its occurrence in a large majority of cases consists the novelty of the point under consideration. This being the fact, it seems surprising that it should have been so long overlooked.

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[1] Archives Générales de Médecine, 1852.

An explanation, offered by Dr. Roger, of the frequency of its occurrence having escaped attention, is that practitioners after making the diagnosis of the presence of liquid effusion, have not been in the habit of comparing the two sides of the chest, above the level of the fluid. According to Dr. Roger, the most favorable condition for the sign, is when the quantity of effusion is sufficient to fill a third or half the cavity of the chest, and it does not exist when the quantity is either very small or very large. Dr. Aran, however, has observed it in the early stage of pleurisy, in which the amount[2] of effusion was quite small. The rationale of the sign is a matter open for discussion. The few remarks pertaining thereto that I shall offer, I will defer till other conditions also characterized by tympanitic resonance have been noticed.

Exaggerated and tympanitic resonance exists sometimes over the lower lobes when solidified in pneumonitis. The credit of having first called attention to this fact, is attributed to the late Dr. Graves, of Dublin. On the left side this is not uncommon, and the explanation which at once suggests itself, and which is probably applicable to many instances, refers the resonance to the transmitted gastric sound so frequently found in health at the inferior portion of the left side. On the right side it may be due to the presence of gas in the transverse colon.

An exaggerated and tympanitic resonance over the superior lobes in cases of pneumonitis in which the lower lobes are solidified, is not unusual. This has been noticed by several observers. Judging from the results of recent observations directed to this point, I should say this was the rule. This, then, is to be classed among the different morbid conditions in connection with which increased sonorousness with the tympanitic quality is produced, if not uniformly, yet in a certain proportion of cases.

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[1] See Essay on Chronic Pleurisy, by author.

[2] Note to French translation of Skoda's Treatise.

Belonging to the same category is the occurrence of tympanitic resonance occasionally, more or less intense, over consolidation of the superior portion of the lung from pneumonitis or tuberculosis. This I have repeatedly observed. Skoda has also demonstrated the co-existence of tympanitic resonance with œdema and pulmonary apoplexy, and Dr. Roger has observed it in lobular pneumonia.[1]

These developments, in a great measure of recent date, are of considerable importance in their practical bearing on physical exploration. A sonorousness greater than natural and tympanitic in quality, may be present in connection with physical conditions of the parts within the thorax, which *à priori* would not be expected to give rise to such an effect, and which, in fact, often, if not generally, are accompanied by dulness or flatness. Whether or not we may be able to account for the facts which have been stated, they are established by clinical observation. Irrespective, therefore, of theoretical views relative to their rationale, the facts are to be borne in mind. To repeat them, in general terms,—in cases of pleurisy with effusion, or hydrothorax, the resonance above the level of the liquid is frequently more intense than on a corresponding situation on the non-affected side, and tympanitic in quality; in cases of pneumonitis affecting an inferior lobe, the healthy lung above the limits of respiration generally emits a resonance more or less intense and tympanitic; and over solidified lung, not only when the lower lobe is the portion affected, in which case we may suppose a gastric or intestinal sound is transmitted, but also when the solidification is situated in a superior part, be it from tubercle, from extravasated blood, or lobular pneumonitis, an exaggerated and tympanitic resonance may exist over the situation of the solidified portions.

Without attention to these facts, the greater sonorousness on one side existing in connection with the several morbid conditions just mentioned, might possibly lead the observer to conclude that the healthy side, from its being relatively dull on percussion, was the side diseased, the morbid resonance being taken as the standard of health in the individual examined. M. Roger states that he has known of instances in which this mistake was committed. Especially in the diagnosis of early tuberculous disease, it is important to recollect that an exaggerated tympanitic resonance at the summit of the chest may attend the presence of tubercles. Such instances are exceptions to the general rule, stated under another head, that a tuberculous deposit occasions diminished resonance on percussion.

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[1] Dr. Roger, in Archives générales de Médecine, 1852.

The rationale of the foregoing interesting and important facts is a matter at present *sub judice*, and inasmuch as I have no fruits of personal experiments or researches to offer, I shall not engage in a lengthened discussion of the subject. To account for an exaggerated tympanitic resonance under circumstances in which it is clinically exceptional, and apparently opposed to the laws of physics, viz., when the lung is compressed by the presence of liquid, or rendered more dense than natural by solidification, the doctrine has been advanced by Skoda that "if the lung contains less than its normal quantity of air, it yields a sound which approaches to the tympanitic, or is distinctly tympanitic."[1] He bases this doctrine on experiments made upon the pulmonary organs in the dead subject, and also removed from the body, taken in connection with the facts pertaining to disease which have been presented. Clinically this doctrine cannot be considered to hold good in the light of a general law for abnormal sonorousness in cases in which the lungs are to a greater or less extent deprived of their normal quantity of air, in other words rendered more dense by disease, is by no means an invariable sign, but, on the contrary, occurs only as an exception to the general rule. The sign, therefore, cannot be due simply to the mere deprivation of air, or any constant condition, but to some contingent circumstances. The question, then, is, what are these contingent circumstances? In cases of effusion within the pleura, the natural effect is to condense the lung by compression of the liquid; but it is not certain that in all instances the proportion of air to the solid tissues above the level of the fluid is diminished. By the force of the inspiratory movements causing greater dilatation of the cells, the ratio of air may perhaps even exceed the limits of health. It is not improbable that the origin of the emphysema and dilatation of the bronchiæ which sometimes succeed pleurisy may have a date anterior to the absorption of the effused liquid. These are points which claim investigation.

But in cases in which abnormal sonorousness at the summit of the chest occurs in connection with solidification of the lower lobe from pneumonitis it is gratuitous to suppose that the relative quantity of air to solid tissues in the upper lobe is diminished. Its occurrence under these circumstances is evidence against the necessity of diminution of air in other instances. Dr. Roger found by experiments that the sound elicited by percussing a lung removed from the body is modified according to the substance on which it rests. Thus on a bed of muscle or bone it emitted a normal sound, but floating on the surface of a liquid it yielded a tympanitic sound. This fact may be applied to explain the abnormal resonance incident to pleuritic effusion, but not to that found to exist in certain instances over the healthy lung in cases of pneumonia.[1]

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[1] Markham's translation, Am. edition, page 47.

The tympanitic resonance, more or less intense, which is observed over solidified lung at the inferior portion of the chest, especially on the left side, admits of an explanation already stated, viz., transmitted sonorousness from the stomach and intestines. When it is presented at or near the summit of the chest, over deposits of tubercle or extravasated blood; or in cases of pneumonitis affecting the upper lobe, some other explanation is requisite. It has been attributed to two incidental circumstances, viz.: 1. The air in the trachea and large bronchial tubes, in consequence of surrounding solidification, may be supposed to give rise to a resonance more or less intense, and of course devoid of the vesicular quality, in other words tympanitic, resembling the sound produced by percussing the trachea: this is the explanation offered by Dr. Williams.[2] According to Skoda, direct experiments prove its incorrectness. He does not give an account of the experiments to which he refers: and deductions from experiments made out of the body, applied to the parts *in situ*, are to be received with a certain amount of distrust. The explanation is adopted by so high an authority as Dr. Walshe on subjects pertaining to physical exploration, and it is considered by him adequate in part to explain the tympanitic sonorousness[3] which is found at the summit of the chest in cases of pleuritic effusion. An interesting case reported by M. Monneret, of Paris,[4] goes to show, that in some instances, at least, of the latter description, this explanation may be valid. In this case, a patient at the Hospital Necker, in connection with the physical evidence of liquid in the chest, the percussion-sound at the summit, behind and in front, was persistingly tympanitic and at the same time dull. Paracentesis was resorted to, and a certain quantity of pus removed. Subsequently there took place perforation of the lung from the pleural surface within. After death, it was found that exactly within the limits of the tympanitic percussion-sound at the summit of the chest, the lung was firmly attached by old adhesions. The reporter attributes the tympanitic resonance in this case to the air within the bronchial tubes modifying the sound in consequence of the close attachment of the lung to the walls of the chest.

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[1] I have observed in a case of pneumonitis affecting the lower lobe of the right lung, the physical signs of well-marked moderate emphysema limited to the upper lobe on the affected side, viz., tympanitic resonance, diminished intensity of the respiratory murmur, and increased convexity in the infra-clavicular region. Is not this significant of the condition giving rise to tympanitic resonance at the superior part of the chest on the affected side, both in cases of pleurisy and pneumonitis?

[2] Lectures on Diseases of the Chest. Dr. Walshe attributes the suggestion to Dr. Hudson.

[3] Called by Dr. Walshe *tubular*.

[4] Gazette des Hôpitaux, August 31, 1854.

2. The second incidental circumstance referred to is emphysematous dilatation of the cells in the vicinity of the solidified portions of lung. It is sufficiently intelligible that a tympanitic resonance should exist under these circumstances; and this is admitted by Skoda. That the air-cells surrounding portions of lung rendered solid by tuberculous deposits, or other forms of disease, are consequently liable to become emphysematous, is an admitted fact in pathology, and accords with the ingenious theory of the mechanism by which emphysema is produced, lately advanced by Dr. Gairdner of Edinburgh.[1]

It is readily conceivable that the two circumstances just stated, viz., the air contained in the bronchial tubes giving rise to resonance in consequence of solidification of the parts lying between these tubes and the walls of the chest, and local emphysema, may be combined contributing conjointly to render the percussion sound more or less intense and tympanitic.

Thus far the expression tympanitic resonance has been considered in a generic sense, as a non-vesicular sound, differing in different instances only in intensity. It is occasionally presented with peculiar modifications of quality, which are in some measure significant of a special pathological condition. These modifications may be embraced in two classes, viz., *amphoric resonance*, and the *cracked-metal sound* (*bruit de pot fêlé*).

Amphoric resonance denotes a metallic ringing sound, such as is sometimes elicited by percussing over the stomach, and which may be imitated by striking the cheek when the jaws are moderately separated and the integument rendered somewhat tense, as is done in the trick of imitating the pouring of liquid from a bottle. The percussion-sound occasionally assumes this peculiar intonation in pneumohydrothorax; and possibly also in cases of solidification from inflammation or tuberculous deposit. But in the vast proportion of the instances in which it occurs it is occasioned by a tuberculous excavation of considerable size, and, of course, more or less empty. Although not an infallible sign of a cavity, the evidence is very nearly conclusive if it be confined within a circumscribed space, at the summit of the chest. Piorry calls it a "water-sound," under the supposition that air and liquid contained in a cavity are necessary for its production. This opinion, according to Skoda, is disproved by experiments.

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[1] The second explanation will hardly apply to cases in which the entire upper lobe is solidified in pneumonitis, and under these circumstances I have repeatedly noted the presence of tympanitic percussion-resonance. There seems in such cases to be no alternative but to adopt the explanation of Dr. Williams. That the tympanitic resonance in such instances is not transmitted from the stomach (on the left side) is probably proved by this fact, which I have repeatedly noted, viz., the pitch of the tympanitic sound at the summit, and that of the gastric tympanitic sound at the lower part of the chest, may present a marked disparity.

The cracked-metal sound, as the title implies, resembles that produced by striking a cracked metallic vessel. It may be imitated by folding the palms of the hands loosely and striking the dorsal surface on the knee, in the manner frequently done to amuse children, producing a sound as if pieces of money were placed between the palms. This, like the ordinary amphoric resonance, usually denotes a cavity, but not invariably. Several observers have noticed it in children at the summit of the chest in thoracic affections without excavation, and even when no pulmonary disease existed. Two striking instances have fallen under my own observation. In one, a child five years of age the sign was marked in the left infra-clavicular region, and after death there was found an abundance of tuberculous deposit without excavations, but lying directly beneath the left bronchus, was a mass of tuberculous matter, the largest collection found anywhere being about the size of an English walnut. In the other case alluded to, the child was reduced to extreme emaciation, but without cough or other symptoms of pulmonary disease. The sign in the latter case was so well marked that the patient was several times presented to a medical class to illustrate the peculiar character of the cracked-metal resonance. The production of this sound is now generally attributed to the air being suddenly and forcibly expelled from a cavity communicating with the bronchiæ by several free openings, precisely as the blow on the knee expels the air between the palms in the experiment mentioned by which the sound may be imitated. To elicit the sound a forcible percussion is necessary, and a single blow is better than several strokes repeated in quick succession. The patient's mouth should be open. If the mouth and nostrils are completely closed the sign is not heard. This fact appears to demonstrate the production of the sound in the manner just stated. When it occurs in children without the existence of a cavity, it is due to the air being expelled from the larger bronchial tubes as it is from an excavation. Percussion at the summit of the chest in children may be brought to bear on the bronchial tubes with greater effect than in adults, owing to the greater elasticity of the costal cartilages in early life. The sign, however, has been observed in adults in cases in which consolidation of the lung existed. Occurring at the summit of the chest in a circumscribed space, especially if not near the sternal extremity of the infra-clavicular region, and if associated with symptoms denoting advanced tuberculous disease, the cracked-metal resonance is almost conclusive evidence of the existence of a cavity, but the evidence may frequently be rendered complete by its association with other signs.

It would be an error to suppose that either of the preceding varieties of tympanitic resonance is found, save in a very small proportion of the cases in which excavations in the lungs have taken place. For the peculiar sounds to be produced, the cavity must be of considerable size; the walls must be sufficiently rigid, not to collapse, when free of liquid contents; it must be situated near the superficies of the lung, or the pulmonary substance between the cavity and the walls of the chest must be solidified; and other conditions may be essential, the importance of which is not so appreciable. Cavities resulting from circumscribed gangrene, or abscesses in connection with pneumonitis, do not embrace the necessary physical conditions, and the signs are therefore chiefly significant of tuberculous excavations. They may occur in connection with pouch-like enlargement of the bronchiæ.

It would also be an error to infer that whenever a cavity gives rise to well-marked tympanitic resonance on percussion, the sound is necessarily either amphoric or of the cracked-metal character; a tympanitic, *i. e.* a non-vesicular resonance, may be elicited over a cavity without any special modification of the quality of the sound. Under these circumstances, how is a cavernous resonance to be distinguished from the resonance which in some cases of tuberculous disease is found at the summit of the chest prior to softening and excavation? Guided by the evidence which percussion alone affords, it would certainly be difficult, if not impossible, to make the discrimination. If a distinct tympanitic resonance, with no peculiarity of character, be found over a circumscribed space, at the summit of the chest on one side, the sound elicited around the border of this space being dull, the evidence thus derived solely by percussion of the existence and situation of a cavity, is very strong; and the evidence becomes quite conclusive if, the disease having been of considerable duration, and attended by pretty copious expectoration, it should be found by percussing at different periods of the day, that the tympanitic resonance is sometimes present, and at other times absent: the former being observed to occur after free expectoration, and the latter when there is reason to suppose that the cavity is filled with the morbid products which are expectorated. Occasionally a tympanitic resonance at the summit of the chest, on one side, is found to be suddenly developed in a circumscribed space, in which previous dulness had been ascertained to exist, and this occurs after a more or less copious emission of puruloid matter by expectoration. Under these circumstances the evidence of a cavity is quite conclusive.

The physical diagnosis of excavations, however, does not rest exclusively on the evidence afforded by percussion. Important signs are obtained by other methods of exploration, especially auscultation. So far as percussion is concerned, indeed, the results of percussion are much oftener negative than otherwise, owing to the cavities being more or less filled with liquid, or other circumstances not being favorable for the production even of simple tympanitic resonance.

SUMMARY.

The abnormal sounds developed by percussion are distinguished from each other, and from the normal thoracic resonance, by variations in timbre, or quality, in intensity, in pitch, and in duration. For practical purposes it suffices to arrange them into divisions based on differences in intensity and in quality; variations in pitch and duration furnishing incidental characters. Thus arranged, the several classes of abnormal sounds are as follows: 1, exaggerated vesicular resonance; 2, diminished resonance; 3, absence of resonance; 4, tympanitic resonance.

1. Exaggerated vesicular resonance is characteristic of vesicular emphysema. It is highly distinctive of that affection, unless the distension of the cells and expansion of the thoracic walls be very great, when the sonorousness may be diminished. Exaggerated resonance from emphysema retains the vesicular quality distinctive of

normal resonance, but this quality may be diminished more or less, and the sound approximate in timbre to the tympanitic. In proportion as the latter alteration takes place, the pitch is raised.

2. Diminished resonance, or dulness, occurs, as a general rule, when a thin stratum of liquid removes the lung a short distance from the chest; when the pulmonary substance is condensed by pressure of liquid effusion within the pleural sac, or, more rarely, by fluids in the bronchial tubes, by serous effusion within the cells or areolar tissue, and by vascular engorgement; by tumors encroaching on the thoracic space, and by deposit of solid products within the lungs, viz., coagulable lymph, tubercle, carcinomatous matter, and a bloody clot; *cæteris paribus*, the degree of dulness is in proportion to the extent to which the air-cells are compromised, and the relative quantity of air to the solid parts reduced. Important exceptions to this rule are observed. In a large proportion of cases of pleural effusion, the percussion-sound above the level of the liquid, for a variable period during the progress of the disease, is exaggerated, and in its character tympanitic. The same is true of the percussion-sound over the healthy lobe on the side in which the lower lobe is solidified in pneumonitis. A tympanitic resonance is propagated from the stomach and intestines in cases of solidification of the lower lobes, more especially the left lobe. It accompanies also, sometimes, partial solidification from tubercle, or other deposits at the summit of the chest. Whenever the sound becomes dull, the pitch is raised, and the duration shortened. The pitch is also higher when it becomes tympanitic. The diseases in which diminished resonance occurs, with the exceptions just stated, are pleurisy and hydrothorax, above the level of the liquid; pneumonitis; œdema of the lungs; great congestion; pulmonary apoplexy; carcinoma, and tuberculosis.

3. Absence of resonance, or flatness, is occasioned by an accumulation of liquid in the pleural sac, and exists below the level of the liquid; sometimes by complete solidification in pneumonitis, and by tumors, or morbid growths. An increased sense of resistance, under these circumstances, is marked.

4. Tympanitic resonance embraces all abnormal sounds (exclusive, of course, of flatness, which is, strictly speaking, absence of sound), which are non-vesicular. It exists in the most marked degree in cases of pneumo-hydrothorax. But in this affection, if the walls of the chest are distended so as to be made quite tense, the sound may become dull, although in character still tympanitic. The sound

transmitted from the stomach or intestines, when percussion is made over solidified lung, is purely tympanitic. The sonorousness sometimes existing over condensed lung, or lung solidified by morbid deposits, at the summit of the chest, is also more or less tympanitic. A tympanitic resonance may also be developed by percussion over tuberculous excavations. In the latter case it is circumscribed in extent. Tympanitic resonance, under these circumstances, occasionally presents a ringing metallic intonation, and it is then called *amphoric resonance*. This modification is sometimes observed when sonorousness exists over solidified lung. Another modification is a *cracked-metal sound* (*bruit de pot fêlé*), sometimes produced by percussing over a cavity of considerable size, superficially situated, having rigid walls, and communicating freely by several orifices with the bronchial tubes. The same peculiar sound, however, has been repeatedly observed in children at the summit of the chest, being caused by the forcible expulsion of the air from the bronchial tubes.

HISTORY.

Percussion was first proposed as a means of determining the nature and seat of diseases by Leopold Auenbrugger, born in Graetz, in Styria, in 1722. Auenbrugger was the author of two works on madness, of a drama, and wrote on dysentery. His work on percussion was thus entitled: *Inventum novum ex percussione thoracis Humani ut signo abstrusos interni pectoris morbos detergendi.*[1] The author died in 1809. The subject attracted scarcely any attention, and had fallen into oblivion, when, thirty years afterward, the method was applied to the diagnosis of affections of the heart, by the distinguished French physician Corvisart, who translated Auenbrugger's treatise into the French language in 1808. The latter was translated into English by Dr. Forbes in 1824.

The value of percussion was immeasurably enhanced by the discovery of auscultation. Of those who have cultivated the art of percussion, since the time of Corvisart, M. Piorry, of Paris, is by far the most prominent. Mediate percussion was introduced by him. He is the author of several works on the subject.[1] In practice, however, he places too exclusive reliance on this method, rejecting auscultation; and he professes to achieve results with the pleximeter, to which others with equal ability, and not less conscientiousness, have failed to attain.

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[1] One cannot avoid an emotion of sorrow at the thought that Auenbrugger, who devoted seven years to researches, as he says *inter tedia et labores*, could not have enjoyed during his lifetime the satisfaction of seeing the importance of percussion in some measure appreciated. In this respect the discoverer of auscultation was far more favored.

The idea of combining auscultation with percussion may be said to have originated with Laennec. He resorted to it, however, to a very limited extent. The plan of practising the two methods simultaneously, with a view especially of determining accurately the situation and dimensions of the solid viscera encroaching on the thoracic space, which, although it has not come into general use, and perhaps never will, in consequence of the ordinary simpler modes being adequate to most of the objects to be attained by percussion, originated with Drs. Cammann and Clark, of New York.

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[1] Traité de la Percussion médiate, Paris, 1828, and Du Procédé opératif de la Percussion, Paris, 1831. The views of M. Piorry are also embodied in a more recent work, by one of his pupils, M. Maillot, *Traité de la Percussion médiate, etc.* The latter has been translated into English, but not republished in this country.

CHAPTER III.

AUSCULTATION.

The term auscultation is applied to the act of listening to the sounds produced within the chest, in connection with respiration, speaking, and coughing. The use of the term in this restricted sense is conventional. Properly speaking, the phenomena developed by percussion, involving, as they do, in their application equally an act of listening, should come within the domain of auscultation. There is, however, this distinction, viz., in percussion the sounds are produced by the manipulations of the listener, while in auscultation they result from the actions, either instinctive or voluntary, of the patient. The explorer, in the one case, is an active agent in originating the impressions received through the sense of hearing; in the other case he is little more than a passive recipient. Another point of difference is, that percussion may be practised on the dead as well as on the living body, while auscultation is available only so long as life continues.

The act of listening to sounds emanating from the thorax, may be performed in two ways, viz., with the ear applied directly to the chest, or by means of a conducting medium. These two modes are distinguished by the same terms employed for an analogous purpose in percussion, viz., *mediate* and *immediate.*[1] In *immediate auscultation*, the sounds are received by the ear placed in immediate contact with the chest. *Mediate auscultation* requires an instrument, which is interposed between the chest and the ear of the listener, through which the sounds are transmitted. This instrument is called the *stethoscope*, a term signifying chest-explorer.

The question at once arises, of the two modes of practising auscultation, which is to be preferred? Each mode has its peculiar advantages, and neither should be adopted to the exclusion of the other. Immediate auscultation is the simpler mode; it is in most cases practised more readily, and the exploration of the whole chest is more expeditiously made. In a large majority of cases, to one practically familiar with auscultatory phenomena, it suffices for all that is desired with respect to the diagnosis. With children, who are apt to be frightened at the appearance of an instrument, this mode is often alone available. But in certain parts of the thoracic surface the ear cannot be applied, for instance, the axilla and the post-clavicular region. If the patient be so feeble as not to be able to be raised from the recumbent posture, and the bed be low, the position, on the part of the explorer, necessary to practise immediate auscultation, renders it inconvenient and difficult. The uncleanly condition of patients is often not a trifling objection; and with females, delicacy, or, at all events, fastidiousness, may oppose a resort to this mode over the anterior surface of the chest.

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[1] These terms were first employed by Laennec, and subsequently borrowed and applied to percussion by Piorry.

Mediate auscultation becomes almost necessary in some instances, in which it is important to isolate the phenomena produced at a particular point from those of the surrounding parts. When the head is placed in apposition to the thoracic walls, sounds emanating from a considerable distance are brought within the focus of hearing, being conducted by the parts surrounding the ear which is in contact with the chest. With the stethoscope, the area whence the sounds are transmitted is more circumscribed, and this is an important advantage under some circumstances, as in seeking for the auscultatory signs of an excavation, or of tuberculous consolidation contained within narrow limits. In some cases in which the surface of the chest has been rendered very irregular by injuries, or deformities, auscultation is available only by means of the stethoscope. Neither mediate nor immediate auscultation, then, is to be cultivated or practised to the entire neglect or exclusion of the other, but each is to be resorted to as it may be specially indicated, and frequently both employed in the same examination.

The part performed by the stethoscope in auscultation was much exaggerated by the illustrious discoverer of this method of exploration, and is still misunderstood by many. Laennec appears to have regarded it in the light of an ear trumpet rendering sounds more audible than they appear to the unassisted ear. It is simply a conducting medium. It does not augment sonorous vibrations. And the glory which will ever attach to the name of Laennec, as has been justly remarked, is in no measure derived from the invention of the stethoscope, but solely from the discovery of auscultation. A great variety of stethoscopes are in use. Almost every one who has bestowed special attention on this branch of practical medicine, seems to have felt it incumbent to originate an instrument possessing some one or more peculiarities which frequently are of no practical importance. The material of which it is made, its size, length, form, etc., offer wide scope for diversity of construction. But the truth is, that if the sounds are conducted to the ear, the construction of the instrument is in a great measure a matter of taste or convenience. The conducting power, indeed, is of less consequence than might be at first imagined, provided the sounds are fairly transmitted; for intensity, as a general remark, is of less value than other features by which auscultatory signs are recognized and discriminated, and often it is of very little account whether the phenomena due to respiration are strongly or feebly conveyed to the ear, if they are distinctly appreciable. The first stethoscope constructed by Laennec was composed of three quires of writing paper rolled compactly in the form of a cylinder and secured by paste. Afterward a cylinder of wood was substituted, and of this material the instruments employed since the time of Laennec have generally been made. Wood is not the best medium for the transmission of sound, but owing to its lightness, and some other recommendations, it is to be preferred to metal or glass, which are better conductors. Instruments have lately been constructed of gutta percha; with these I have had no practical acquaintance. They are recommended as fulfilling all the conditions of a convenient stethoscope by competent authority.[1] It would be quite unnecessary, to say the least, to enter into a discussion of the numerous details pertaining to the length, size, form, etc., of the cylinder. It will suffice to notice, briefly, the general principles to be observed in its construction. Some (Hughes, Watson, and Blakiston) prefer solid wooden cylinders. Most of the instruments, however, in common use are perforated through the centre, and the general impression is, that the sound is conveyed partly along the woody fibres, and in part by the column of air enclosed within the canal passing through the cylinder. Of the different kinds of wood, either cedar or ebony is usually selected from their lightness and straightness of fibre. The instrument should be of sufficient length for the head to be removed to a comfortable distance from the body of the patient; but if it be too long, there will be difficulty in keeping it accurately adjusted to the chest. Six to ten inches are the limits of a convenient length. The end applied to the ear (the aural extremity), should be broad and moderately concave, so as to receive the external ear, and admit of pressure upon the whole surface, with the head, without closure of the meatus. Many stethoscopes are faulty in these points; the aural extremity is too small, and the concavity either too great or insufficient. But the same instrument will not equally fit the ears of all persons, and, as Dr. Walshe remarks, "it is as necessary to try on a new stethoscope as a new hat." It is better that the ear piece be of the same material as the body of the instrument. It is frequently made of ivory, which may be more pleasing to the eye, but diminishes somewhat the conducting power. The end applied to the chest (pectoral extremity), should be trumpet or funnel-shaped, and not too large. A diameter of an inch, or an inch and a half, is sufficient. The edges should be rounded so that the requisite amount of pressure shall not hurt the skin. For the sake of lightness, the body or stem of the instrument may be reduced in size to a cylinder of the diameter of half an inch, if the material be ebony, or an inch or so, if it be cedar. The exterior and the bore of the instrument, should be smooth and polished. With these few data the student or practitioner might cause one to be constructed, or, imitating the example of Laennec, construct one with his own hands without any model. Stethoscopes, however, are so common, that it is only necessary to select from a variety of specimens the one which appears best to combine the conditions just stated. Habit will be found to have much to do with the ease and facility with which a particular instrument is employed; and it is undoubtedly true that a stethoscope defective in certain points of construction will be preferred by one accustomed to its use, over another which is in reality superior, but to which he is not habituated.

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[1] Dr. J. Hughes Bennett.

Flexible stethoscopes are used to some extent, and by some preferred to the wooden cylinder. Their introduction in this country is due to Dr. Pennock, of Philadelphia. A flexible instrument several years ago was devised by Dr. Pennock, constructed of coiled metallic wire, covered with a silk or worsted web; the pectoral extremity consists of a metallic cone, and to the aural extremity a tube is attached, also of metal, which is introduced within the external ear. The chief recommendation of a flexible stethoscope is that it admits of application to different parts of the chest, without the necessity of much change of position on the part either of the patient or operator. In some instances this is an important desideratum. The instrument is a sufficiently good conductor of the thoracic sounds. A disadvantage of it is, that the pectoral extremity requires to be held in apposition to the chest with one hand, and the aural extremity kept within the ear by the other hand. Sounds produced by the contraction of the muscles of the hands, and by friction on the instrument, are apt to be commingled with those received from the chest. A little practice, however, enables the listener to disconnect the latter and observe them separately. In this variety of stethoscope, if not indeed, in the ordinary wooden cylinder, the column of air appears to be the important conducting medium; and, in fact, a common ear-trumpet, with a caoutchouc tube, answers the purposes of a stethoscope. M. Landouzy, of Paris, has suggested a stethoscope with a number of gum-elastic tubes, by means of which several persons may auscultate simultaneously. Dr. Marsh, of Cincinnati, has invented and patented an instrument with two tubes. A peculiar feature of the latter is a gum-elastic membrane stretched across the pectoral extremity. I cannot speak of this instrument from any practical knowledge of it.

Quite recently a flexible stethoscope on a novel plan has been invented by Dr. Cammann, of New York. It consists of a bell-shaped pectoral extremity, made of ebony, and about two inches in diameter, to which are attached two tubes of metallic wire covered with gum-elastic, and with the latter are connected two tubes of German silver, gently curved, and ending in ivory knobs, which are intended to be introduced within, and to fill accurately, the external ear on each side at the same time. The sounds are thus received through both organs of hearing, and other sounds than those transmitted by the instrument are excluded.

In the construction of this instrument the agency of the column of air in conducting the thoracic sounds is supposed to be established experimentally; for it is stated that the solid media were changed many times without the conducted sound losing its intensity, and the sound was lost by making the pectoral extremity solid. Thoracic sounds are heard by means of this instrument with great intensity; and are rendered distinct when scarcely appreciable by the naked ear, or with the ordinary cylinder. In the latter respect it serves virtually to enlarge the application of auscultation by developing positive results in cases in which, by former modes of examination, the signs are negative. It also renders auscultation available to those whose sense of hearing is impaired. Conducing, however, in a striking degree to the intensity of sound, the quality and pitch are altered, as indeed, is stated by the inventor. In making trial of the instrument, I have found it more difficult to institute comparisons as regards quality and pitch of sound than with the ear alone, or the ordinary stethoscope; but with reference to differences of intensity, and in rhythm, it admits of a wider application than the common modes. It renders distinctly audible, also, morbid sounds in some instances in which they are too obscure to be studied satisfactorily without its aid. For comparison of the two sides of the chest as respects the resonance produced by the act of speaking, it is exceedingly well adapted.

With these advantages the invention is entitled to be considered a valuable contribution to the means of physical exploration. In using the instrument it is to be borne in mind that it conducts sounds produced exterior to the chest in no less a degree than those emanating from within the thorax. The slightest friction of any substance upon it gives rise to a loud sound. The pectoral extremity must be applied to the naked skin to avoid this source of extrinsic sounds. It is intended to be a self-adjusting stethoscope, but in order to keep it firmly and equally applied, I have found it necessary to hold the pectoral extremity between the fingers; this is a source of extraneous sounds which by practice are to be guarded against as much as possible, and recognized when they are produced.[1]

With the aid of an assistant, or of the patient himself, in keeping the pectoral extremity of this stethoscope to the chest, it must be admirably suited for auscultatory percussion, as proposed by its inventor in connection with Prof. Clark.

In the performance of auscultation certain rules are to be observed, the more important of which may be here stated. Whenever practicable, the person to be examined should be seated in a chair with a high back, furnishing a firm support for the shoulders, which are to be thrown moderately backward when the chest is explored in front. In examining the back a stool is preferable, or, if the patient be of the male sex, his position may be reversed, the face turned to the back of the chair; the body should be inclined forward, the arms folded as in practising percussion on the posterior surface of the chest. In exploring the lateral surfaces the hands should be clasped upon the head, as when percussion is made in this situation. If the patient be confined to the bed, the chest in front may be examined in the recumbent posture, and afterward, if the disease be not accompanied by extreme debility, he may be raised, and supported in a sitting position while the examination is made behind and laterally. It is sometimes the case that patients are too feeble to endure a vertical position of the body even for a short time. Inclining the body first on one side and then on the other, a partial exploration may be made under these circumstances, by means of the flexible stethoscope. It rarely occurs, however, that when a careful examination of the back is desirable, a favorable position is impracticable. It is more satisfactory to divest the chest of all clothing, in order to judge better of corresponding points on the two sides to be explored in alternation. So far, however, as concerns the transmission of sounds, this is not necessary. A single thin covering of cotton or linen offers little or no obstruction, nor is it a serious hindrance to determining often with sufficient accuracy the particular parts of the chest to be examined in succession. Several thicknesses, or a thick woollen article of dress, interferes with the appreciation of auscultatory phenomena. If a covering remain, it should be soft and flexible, so as not to occasion a rustling noise from the movements of the chest, or by friction against the ear or stethoscope. In immediate auscultation a soft napkin, or handkerchief, may be interposed between the skin and the ear, in order to obviate the disagreeable circumstances often attendant on applying the head to the naked surface. A regard for delicacy prevents complete exposure of the chest of the female. The portions, however, most important in cases in which a minute and visual examination is most likely to be required, viz., the summit in front and behind, may, without impropriety, be divested of the dress. The temperature of the room should be properly regulated, especially if the chest be exposed. This is important not only to obviate the liability of the patient suffering injury from the impression of cold on the surface, but to prevent a difficulty which may interfere with the examination. The action of cold on the muscles of the chest sometimes occasions trembling movements accompanied by a rumbling noise which obscures the intra-thoracic sounds, and without knowledge of this source of an exterior murmur, it might be supposed to emanate from within the chest. The position of the explorer should be one favorable for listening with attention, and which may be maintained for some time without fatigue or discomfort. If he assume a constrained posture his mind will be diverted from the object of the examination to his own sensations, and he will be unable to reserve his perceptions exclusively for the thoracic sounds. A stooping posture is, as much as possible, to be avoided, not only for the reason just mentioned, but because the gravitation of blood to the head induces a temporary congestion, which dulls the sense of hearing. It is not uncommon to see practitioners inclining their heads so low in performing auscultation that the face becomes deeply injected, and the veins largely dilated. I find it most convenient and comfortable to rest upon one knee. In this position the head may be placed in contact with the chest, and kept upright, or nearly so. Of course these precautions have reference to the practice, either of immediate auscultation, or the use of the wooden cylinder. With a flexible stethoscope from one to two feet in length, the explorer may remain sitting by the side of the patient, the latter lying, or seated, as the case may be. This is one of the recommendations of this instrument to be placed against its disadvantages.

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[1] Dr. Cammann's stethoscopes are manufactured and sold by Messrs. George Tieman & Co., No. 63 Chatham St., New York.

The ear is to be pressed against the chest, or on the cylinder, with a certain amount of force. If the pressure be made too lightly the sounds are not transmitted, or an unnatural character may be communicated to them which may be mistaken for morbid phenomena. Thus the resonance of the voice by the non-observance of this rule, sometimes assumes a modification analogous to that incident to certain morbid conditions, constituting the physical sign called ægophony. On the other hand, if too great force be applied, pain may be occasioned sufficient to disturb the respiratory movements, or the expansion of the chest may even be mechanically impeded. Attention to this point, with practice, will enable the auscultator to hit the medium between the two extremes. If the cylinder be employed, the pectoral end should be evenly applied on the chest, and held in place with the fingers of the right hand until the ear is nicely adjusted to the aural extremity. The hand is then to be removed from the instrument, which is to be kept in place by means of pressure with the ear alone. Non-observance of this rule is one of the circumstances by which a mere *formalist* in the practice of auscultation may be detected.

In practising auscultation it is well to accustom oneself to the use of either ear indifferently, if the sense of hearing be equally acute in both. An exploration of both surfaces of the chest can then be made without the necessity for change of position on the part of the explorer. Perfect silence in the apartment is at first necessary. The habit of mental abstraction, and the power to concentrate the attention exclusively on the thoracic sounds, are not generally acquired without more or less pains and perseverance. After a time, however, extrinsic noises are less troublesome, and an exploration may be made under unfavorable circumstances. The ability of acquiring the power to withdraw the senses and thoughts from surrounding objects is not equally possessed by all individuals, and it is owing in part to differences in this respect that some persons become much better auscultators than others. Every one accustomed to physical exploration must have observed that the facility and satisfaction with which examinations are made, differ considerably at different times, owing to differences in the state of mental activity, preoccupation, etc. After auscultating for a time, the quickness and correctness with which thoracic sounds are perceived are liable to be impaired by fatigue. It is a useful caution, therefore, not to continue this kind of investigation too long. From one to two hours of continuous exploration is sufficiently long without an interval of rest.

The acoustic phenomena revealed by auscultation relate to the respiration, the voice, and the act of coughing, the latter being comparatively of little consequence. In listening to the respiratory sounds, the manner in which the patient breathes is a matter of importance. Mental excitement or apprehension often gives rise to more or less disturbance of the respiration. The breathing becomes hurried and irregular, and, on this account, the examination may be unsatisfatory, or even prove abortive. In persons of great nervous impressibility it is frequently necessary to wait until calmness is restored before proceeding with, or completing an exploration. As justly remarked by Fournet, the manner and bearing of the physician have much to do with this point. If he wear a solemn mien, and favor by his looks or actions the idea that the operation is one of formidable import, he will be less successful than if he manages to divest it of repulsive features. With reference to this end immediate auscultation, in which no instruments are exhibited, is to be preferred, whenever the object can be equally well attained by that mode. It is generally desirable to cause the patient to breathe with more than ordinary force in the progress of the examination, and it is sometimes extremely difficult to effect this object satisfactorily. He accelerates the respiration, or takes a deep inspiration and holds his breath, or in different ways alters the rhythm of the respiratory acts. The end desired is simply to render the breathing somewhat more intense without change in other respects; and the best mode of securing the end is to breathe ourselves just as we wish the patient to do, requesting him to observe and imitate us as closely as possible. Another method is to request the patient to cough while the ear is applied to the chest, the respiration succeeding an act of coughing being deeper or fuller than ordinary. In some instances the respiratory phenomena are not appreciable except the force of the breathing be voluntarily or involuntarily increased. It is necessary to caution the unpractised auscultator to avoid mistaking the noise frequently produced by the current of air at the mouth of the person examined, for sounds emanating from the thorax. The patient should be instructed to avoid making labial sounds, which by entering the ear not applied to the chest, tend to distract the attention, if they do not lead to the error just mentioned. In auscultating the voice, the plan usually adopted is to cause the patient to count from one to five, repeating these numbers as often as may be requisite, being careful to utter each numeral with the same tone and strength.

In auscultation, as in percussion, the phenomena of disease are not, as a general remark, determined by reference to any fixed standard of health applicable alike to all individuals. It will be seen presently that auscultatory, not less than percussion-sounds, differ widely within healthy limits. Hence here, as in the practice of percussion, a comparison is instituted between the two sides of the chest. The laws of disease, in a large proportion of cases, permitting one side of the chest to retain the phenomena of health, enable us to judge of morbid phenomena by means of a want of correspondence between the two sides. This remark does not apply to auscultation to the same extent as to percussion, for several of the phenomena revealed by the former are in themselves, irrespective of such a comparison, well-marked physical signs of disease. But in certain instances, as will be seen hereafter, a close comparison of corresponding points of the two sides is very necessary in determining the existence of morbid phenomena. When this is the case, observance of uniformity in every particular in auscultating each side in succession is not less necessary than in practising percussion. The enunciation of this general rule will suffice, without stopping to dwell upon details. Comparison of points in exact correspondence, taking care to make an equal amount of pressure with the ear, causing the respiratory movements or the voice to be as nearly identical as possible, etc., are points not to be overlooked when nicety of discrimination is involved in the diagnosis.

Finally, to employ auscultation successfully, the explorer must be qualified by knowledge and practice to appreciate the sounds incident to respiration and the voice, in the different aspects in which morbid deviations from health are liable to be presented; he must be prepared, in other words, to recognize the morbid phenomena which may exist, and to do this he must make himself conversant theoretically, and as far as opportunities are offered practically, with the facts and principles which have been established by the labors of those who have devoted attention to the subject. Otherwise he is met by all the difficulties which the pioneers in the cultivation of this field of research were obliged to encounter; difficulties, thanks to the genius of the illustrious founder of auscultation, and the labors of his successors, no longer existing to retard and limit the progress of one who at this day aims to become a proficient in physical exploration.

In the study of auscultation, as of percussion, the point of departure for investigating the signs of disease is an acquaintance with the phenomena pertaining to the healthy chest. The remainder of this chapter, therefore, will be divided into, 1. Auscultation in Health, and, 2. Auscultation in Disease.

I. AUSCULTATION IN HEALTH.

It is essential to the application of auscultation to the diagnosis of disease to become practically familiar with the sounds produced by respiration and the voice in health, for without this knowledge it would be impossible to determine whether sounds heard in cases of suspected disease are natural or morbid. But there is an additional reason why the study of the auscultatory phenomena pertaining to the respiratory system in health is to be commended to the student's careful attention before he enters on the subject of the signs of disease, viz.: by means of this preparatory knowledge he is at once qualified to appreciate some of the more important of the morbid sounds. Incongruous as it may at first appear, it will be found to be true, that certain of the most valuable of the physical signs involved in diagnosis, may be studied in persons entirely free from disease. This fact will appear in the sequel. In treating of Auscultation in Health we are to consider the phenomena incident to respiration, to the voice, and to the act of coughing. We will consider these phenomena under separate heads.

PHENOMENA INCIDENT TO RESPIRATION.

These phenomena are by no means the same in all parts of the respiratory apparatus, and it is highly important to study them in different portions of this apparatus separately. The respiratory sounds are widely different, according to the sources whence they are supposed to emanate. As distinguished by their origin, either in the air-vesicles, or different parts of the air-tubes, they may be arranged into three classes, viz.: 1. Those situated in the trachea, and in this class may be included laryngeal sounds; 2. Those produced within the larger bronchi; 3. Those originating in the smaller tubes and vesicles. The phenomena thus incident to tracheal, bronchial, and vesicular respiration are to be investigated separately, and contrasted with each other.

1. TRACHEAL RESPIRATION.—To auscultate the trachea the stethoscope is necessary, which is to be placed in front just above the sternal notch. Applied in this situation a sound is almost invariably found to accompany each respiratory act. The sound with both inspiration and expiration has a certain timbre or quality, conveying to the mind the idea of a current of air forcibly impelled through a tube of considerable size; hence it may be distinguished as a *tubular* sound. This term tubular it is convenient to use by way of distinction. Occasionally the sound has a ringing, metallic quality. The respiratory and the expiratory tracheal sound present some differences, and merit separate notice. The sound with inspiration, if observed for some time, will be found to vary considerably with different respirations as regards intensity. Generally, it is quite intense with ordinary breathing, but it always becomes much more so when the force of the breathing is voluntarily increased. The intensity with forced, but still more with ordinary breathing, differs considerably in different persons. Occasionally it is exceedingly feeble, almost inaudible, except when the force of the breathing is increased. Compared with the expiratory sound as regards intensity, it is frequently, but not generally, more intense in ordinary respiration, but almost invariably in these cases becomes less intense than the expiratory sound in forced breathing. In duration the inspiratory sound falls a little short of the period occupied by the inspiratory act. It attains its maximum of intensity quickly after the first development of sound, and maintains the same intensity to the close of the act, when the

sound abruptly ends, as if suddenly cut off. As regards pitch, it may be remarked, that it is higher, *i. e.* more acute, or sharper, than the sound emanating from the air-vesicles.

The expiratory, like the inspiratory sound, varies in intensity considerably with different respirations, and is habitually feeble in some individuals, while it is strongly marked in others. This statement applies to ordinary respiration. When the respiration is forced, the sound almost invariably becomes intense. In tranquil breathing, its intensity is in some instances greater, and in some less, than that of the inspiratory sound; but in forced breathing, it is almost invariably more intense. As regards pitch, it is, with a few exceptional or doubtful instances, more acute than the inspiratory sound with ordinary respiration, and this is uniformly the case when the respiration is forcibly increased. It presents oftener than the inspiration the quality called metallic. In duration, in the great proportion of instances, it is somewhat longer than the inspiratory sound; and this is more marked in forced than in ordinary respiration. Occasionally the sounds with the two acts are about equal in length. The expiratory, like the inspiratory sound, quickly attains its maximum of intensity, but instead of preserving the same intensity, it gradually becomes weaker, and ends, not abruptly, but is, as it were, lost imperceptibly.

The inspiratory and expiratory sounds are not continuous, but separated by a brief interval.

The foregoing description is based on observations in forty-four healthy persons, the facts being noted at the instant of observation and afterward analyzed.

The characters, then, distinctive of the tracheal respiration, taking, as a type, a respiratory act somewhat more forcible than in ordinary breathing, are as follows:

A sound of inspiration and of expiration; both having a tubular quality; both higher in pitch than the vesicular respiration;[1] a short interval separating the two sounds; the expiratory sound more intense, longer, and higher in pitch, than the inspiratory.

The student should practically verify these characters, and impress them on the memory. They will be seen hereafter to have an important practical bearing on the study of disease. The tracheal respiration, observed elsewhere than over the trachea, is a significant physical sign, of frequent occurrence.

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[1] In order to appreciate this point of distinction in anticipation of the consideration of the vesicular respiration, the student may compare the two by listening to the respiration with the ear applied to the chest after auscultating the trachea.

The laryngeal respiration is said by some writers on auscultation, to differ in a marked degree from the tracheal.[1] I have recorded comparative observations made with care in eighteen persons, and in none of these instances were there any notable points of disparity save in intensity. Frequently the respiratory sounds heard by placing the stethoscope on the side of the larynx were less intense than over the trachea. In other characters they were essentially identical.

It is foreign to my purpose to enter into much discussion concerning the laws of physics by which auscultatory phenomena are to be explained. It is easy to understand why a column of air moving to and fro, with considerable velocity and force, through the trachea, should give rise to a tubular sound. The sound may be imitated by blowing through a tube of uniform size, or through the larynx and trachea removed from the body. The different characters pertaining to the inspiratory and expiratory sounds, may probably be readily accounted for, by reference to the different circumstances belonging to the two acts respectively. The force of the inspiratory movement is sustained equally to its close; hence the intensity of the inspiratory sound is maintained, and ends as abruptly as the act itself. On the other hand, the force of the expiratory movement is greatest at its beginning, and gradually diminishes; hence, a corresponding diminution in the intensity of the sound. The fact that the expiratory act involves more power, especially in forced breathing, explains the greater relative intensity of the expiratory sound; and its greater length, the corresponding longer duration of the sound. The higher pitch of the expiratory sound is in part due to the greater force of this act; but in part, probably, to the greater contraction of the glottis by the approximation of the vocal chords, which recent observations have shown to take place with expiration, the space between the chords dilating regularly with inspiration. This approximation is greater in proportion as the respiration is forced, a fact which corresponds with the more marked elevation of pitch under these circumstances. (Introduction, pages 33 and 53.)

The tone and intensity of the tracheal respiration, may be readily imitated by modulating breath-sounds with the mouth. Skoda has proposed to represent the respiratory sounds peculiar to different situations by means of whispered letters. A similar mode of establishing types of cardiac bellows murmurs, has been long since pursued by Bouillaud and Hope. Following Skoda, the letters *ch*, soft, will represent a tracheal sound. The pitch and loudness may be varied by graduating the force with which the air is expelled when these letters are whispered, and altering somewhat the disposition of the lips. In this way may be reproduced the tubular inspiration, and the more intense sharper sound of expiration, which characterize the respiratory sounds incident to the trachea.

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[1] Ex. gr. Barth and Roger, "Sur le larynx même le murmure varie encore; il ressemble a l'espèce de souffle que dèterminerait l'entrée de l'air dans une cavité plus large; outre sa rudesse, il prend un caractère caverneux beaucoup plus marqué et constitue le bruit respiratoire laryngé." Op. cit. p. 36.

The tracheal respiration may be heard with distinctness, and sometimes with considerable intensity, when the stethoscope is placed on the neck behind, over the cervical vertebræ.

2. BRONCHIAL RESPIRATION.—The normal bronchial respiration is the sound supposed to be produced within the bronchial tubes on either side prior to their entering the lungs. The points where either the stethoscope or ear is to be applied, in order to observe the phenomena incident to this portion of the respiratory apparatus, are in front, between the second and third ribs, close to the sterno-clavicular junction; and behind, in the interscapular space, on a line with the spinous ridge of the scapula. Applied over the upper part of the sternum in front, as directed by some authors, the sound must necessarily come mainly from the trachea. In fact, it is not probable that in the situations lying directly above the bronchi, the respiratory sounds are purely bronchial in their origin. The tracheal respiration may be heard there in some, if not in a greater or less degree, in most persons. Generally, also, the vesicular respiration emanating from the air-cells, modifies, to a greater or less degree, the character of the sound. The normal bronchial respiration is thus, in reality, a mixed respiratory sound, and the differences which are to be noted in different individuals, are to be explained, in a great measure, by the combination, in varying proportions, of the three varieties, viz., tracheal, bronchial, and vesicular respiration. The study, however, of the auscultatory phenomena, in the situations named, is of much interest and importance, not only in order to become conversant with the sounds proper to those portions of the chest, but because they furnish types of phenomena incident to disease in other situations. It will be seen, hereafter, that the different grades of what is distinguished as the normal bronchial respiration, when present in portions

of the chest other than the points where they belong in health, may constitute significant indications of morbid conditions. The student, therefore, by impressing on the memory, and verifying by practice on healthy individuals, the characters and diversities which belong to the normal bronchial respiration, is acquiring knowledge which will be directly available in diagnosis. The previous study of the tracheal respiration will prepare for that of the bronchial, the two being, as will be perceived, analogous, and often, if not generally, essentially identical.

Directing attention first to the anterior surface of the chest, if the ear be applied near the sterno-clavicular junction, a respiratory sound, differing in several important features from that heard over the remainder of the chest (vesicular respiration), is heard in the vast majority of cases. To indicate the several points of difference would require an anticipation of the description of the vesicular respiration. The two kinds of respiration will be fully contrasted when the latter is considered. But in describing the former it will be necessary to imply knowledge of the fact that the bronchial, as well as the tracheal respiration, differs from the vesicular in a tubularity of character, as distinguished from what will be called a vesicular quality, and in greater altitude of pitch. Other distinctive traits need not now be alluded to. The following account will be based in part on examinations of twenty-three persons in health, made several years ago, in order to study the characters of the normal bronchial respiration; and more especially on another series of twenty-four examinations made recently for the same purpose. In both series the memoranda were noted at the instant of observation, and the facts afterward analyzed.

In almost every instance a bronchial sound of respiration was discoverable, both in front and behind, at the points mentioned,[1] on both sides of the chest. In several instances[2] a respiratory sound was either absent or scarcely appreciable, except when the force of breathing was voluntarily increased, and in the degree of intensity marked difference existed in different persons. It was not appreciable with the cylinder in all instances in which it was discoverable, and even well developed, by employing immediate auscultation,[3] a fact

[1] Absent in 7 of 47 cases in front, and 2 of 36 cases behind. These 9 cases all are within the first series of examinations. By employing Cammann's stethoscope a sound could probably have been discovered in every instance. These examinations were made before that stethoscope was invented.

[2] Six of 24 cases in front, and 9 of 22 cases behind.

[3] This fact was noted as follows: In front, of 24 cases, on both sides of the chest, in

which goes to show that by immediate auscultation the tracheal sound is transmitted, since the stethoscope circumscribes the space whence the sound is conducted, while the ear applied directly to the chest derives it from a wider circuit. In a single instance the sound was appreciable with the cylinder and not by immediate auscultation. In two instances it was heard distinctly with Cammann's instrument, when not appreciable either with the ear alone or the ordinary stethoscope. In every instance, either in front or behind, in which the bronchial respiration was compared with that over other parts of the chest, for example, the middle of the infra-clavicular, and in the infra-scapular regions, it was found more or less deficient in the vesicular quality, in other words approximating to the purely tubular character of the tracheal respiration, also uniformly higher in pitch, and differing frequently in other characters.[1]

The bronchial respiration is heard in some persons with both respiratory acts, and in some with the inspiration only. In these points striking differences are observable. Marked disparities are also frequently found to exist between the two sides of the chest in the same person. The readiest way to present an idea of these variations will be to give, as succinctly as possible, the result of the analysis of the examinations already referred to. Limiting the analysis to the twenty-four recent examinations, of this number the bronchial respiration was heard near the clavicular sternal junction with the act of inspiration only, *on both sides of the chest*, in twelve instances, leaving the same number of instances in which it was heard both with inspiration and expiration. Behind, in the upper part of the interscapular space, of twenty-two examinations, it was heard with the inspiration alone, *on both sides*, in seven; leaving fifteen instances in which it was heard with both respiratory acts. According to these examinations, then, an inspiratory and expiratory bronchial sound on both sides of the chest will be found, in front, in the proportion of one half, and behind, in the proportion of two-thirds of persons free from disease.

3 cases; on the right side, 2 cases; on the left side 1 case. Behind, of 22 cases, on both sides, 3 cases.

[1] In making this statement, I am compelled to differ from authorities on the subject of physical exploration so distinguished as Barth and Roger. These writers say (Traité Pratique d'Auscultation, etc., 1854, page 33): "Il ne faudrait pas croire que cette respiration bronchique existe toujours en ces points, et se distingue nettement de la respiration des autres régions: très-souvent l'oreille la plus exercée ne saisit pas de différence sensible."

As respects this point, the two sides are by no means uniformly in correspondence. The inspiratory sound, in a certain proportion of cases, is alone heard on one side, while the inspiratory and expiratory are heard on the other side. This dissimilarity, however, is subject to a rule which, so far as my examinations go, is invariable, viz., a sound accompanies both acts of respiration, not infrequently on the right side only, and this is never observed on the left side. In eight of the twenty-four examinations, a sound accompanied both acts on the right side, in front, while an inspiratory sound alone existed on the left side. This was true of the back in three of the twenty-two examinations; neither in front, nor behind, did a sound with the two acts exist on the left side, and not on the right in a single instance.

It remains to ascertain the results of the analysis as respects other characters of the bronchial respiration, and to institute a comparison between the two sides, in front and behind, as regards intensity of the respiratory sound, disparity in pitch of sound, and the relation of the expiration to the inspiration in intensity, duration, and pitch. We will direct attention now to these several points.

Limiting the attention first to the inspiratory sound, in some instances the intensity appeared equal on the two sides, but in other instances a marked disparity was apparent. The enumerations with respect to this point are as follows: In front, of ten instances in which a disparity of the inspiratory sound was obvious, the intensity was greater on the right side in six and on the left side in four. Behind, of five instances, the intensity was noted greater on the right side in two and on the left side in three. Thus there is no rule restricting the existence of greater intensity of the respiratory sound to either side; but, so far as these few observations go, the intensity is a little oftener greater on the right side in front and on the left side behind. The sum total of the instances, in front and behind, in which the intensity was greater on the right side, is thus eight; and on the left side seven. These results accord in a striking manner with those obtained by an analysis of the previous series of examinations. Of the latter, the intensity was greater on the right side in five of nine instances, and on the left side in four.[1]

Comparing the inspiratory sound on the two sides as regards pitch, in a few instances it is noted that no difference was apparent, but in a large proportion a disparity was obvious. A fixed rule evidently governs this disparity: of twenty instances in which it was observed near the sterno-clavicular junction, in nineteen the pitch was higher on the right side, and in a single instance only on the left side. At the upper part of the interscapular space, in all of nine instances, the pitch was higher on the right side. The results are in accordance with those obtained by the former analysis. The latter developed in twenty examinations, elevation of pitch on the right side in fifteen, no difference in this respect being appreciable in the remaining five.[1] Practically, then, it may be assumed that a disparity in pitch exists in the larger proportion of instances, and that the pitch is almost invariably higher on the right side.

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[1] See Prize Essay on Variations of Pitch, etc., Transactions of Am. Med. Association, vol. v., page 84, et seq.

In tubular character, or in deficiency of vesicular quality, a contrast was observed between the two sides. In this respect the results show an invariable rule, viz., whenever a disparity exists between the two sides, the greater tubularity of sound is found on the right side. This was noted in thirteen instances in front and in three behind.

The foregoing results relate to the inspiratory sound. Directing attention secondly to the expiratory, the relative intensity of the latter to the former is the first point which suggests itself. In a small number of instances, it is noted that the expiration was more intense than the inspiration. The number of instances is five; but it is highly probable that attention was not given to this point in all the examinations. So far as these few observations go, they point to a rule, viz., when the intensity of the expiratory, as compared with the inspiratory sound, is decidedly greater, and confined to one side, the right side is the one presenting this contrast. In all of the five cases in which the fact was noted, it was on the right side.

Comparing the pitch of the expiratory with that of the inspiratory sound, the results are more striking. In a very few instances (three) the expiratory sound was lower in pitch than the inspiratory. In each of these instances it was observed on the left side. In every other instance in which the presence of an expiratory sound was noted, it was higher in pitch than the inspiratory. An expiratory sound higher in pitch than the inspiratory, on the right side, was noted in twelve instances, viz., nine in front, and three behind. In several instances in which this contrast between the two sounds existed on both sides, it is stated to have been much more marked on the right side. The difference in this respect was sometimes very striking.

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[1] See Prize Essay.

The expiration was in some instances observed to be longer than the inspiration. This was oftener noticed on the right side. And in every instance in which attention was directed to the point, a brief interval separated the sound of inspiration and expiration. These results are in accordance with those obtained by the previous analysis.[1]

In view of the foregoing results, the following is a summary of the descriptive facts and distinctive characters pertaining to the normal bronchial respiration, as heard at the sterno-clavicular junction in front, and the upper part of the interscapular space behind. In most persons a respiratory sound may be discovered and studied in these situations, if the force of respiration be increased, by auscultating with the ordinary stethoscope; in a still larger number this is practicable by immediate auscultation, and in nearly every individual, probably, by means of Cammann's instrument; of a given number of individuals, in one-half we may expect to hear an inspiratory and expiratory sound in front; and in two-thirds behind. When a sound with both respiratory acts is found on one side, and not on the other, it is invariably on the right side. When there is a difference of intensity in the respiratory sound between the two sides, the greater degree of intensity is found sometimes on the right, and sometimes on the left side, the proportion of instances being not far from equal. The pitch of the inspiratory sound is generally greater on the right side, and almost never on the left side. In some instances also the inspiratory sound is more tubular in character on the right than on the left side. The reverse of this is not observed. The expiratory sound is sometimes more intense than the inspiratory. When this is more marked on one side than on the other, it is on the right side. The same remark will apply to prolonged expiration. The pitch of the expiratory, as compared with the inspiratory sound, is higher. To this rule there are occasional exceptions, occurring only on the left side. A striking contrast between the two sounds in pitch is characteristic of the bronchial respiration of the right side. When the sounds are heard with the two respiratory acts, a brief interval occurs between them.

These facts are interesting and important to the student of physical exploration, as already stated, in the first place showing that the phenomena found at certain portions of the chest in health, together with

[1] Prize Essay.

the variations and the disparity between the two sides of the chest in these portions, which are not to be considered evidences of disease; and, in the second place, exemplifying in the healthy chest the varieties of the bronchial respiration so-called, occurring as the signs of morbid conditions. In the latter respect it will come up for consideration under the head of Auscultation in Disease.

On reviewing the elementary characters of the normal bronchial and the tracheal respiration, and instituting a comparison between them, it will be perceived that in the more important of these characters they bear to each other a close resemblance. Both are deficient, but the tracheal more completely, in a peculiar distinctive quality, which will presently be seen to characterize the vesicular respiration. Both are high in pitch compared with the vesicular respiration. The expiratory sound in each (with a very few exceptions in the case of the bronchial respiration on the left side), is higher in pitch than the inspiratory. Frequently in the bronchial, as in the tracheal, the expiratory sound is more intense and longer; and an interval separates the two sounds in both cases. The chief points of difference are the greater intensity of the tracheal sound, its purely tubular character, and the constant presence of an expiratory sound.

As already remarked, it may be doubted whether the normal bronchial respiration is exclusively bronchial, *i. e.* produced solely within the bronchial tubes; but it is a combination of a bronchial sound with the tracheal, modified more or less by the vesicular respiration. The sound frequently appears to come from a distance. This was noted in several of the examinations, especially with respect to the expiratory sound. The loud expiratory sound is probably derived chiefly from the trachea. On the other hand, the want of complete tubularity, greater in some instances than in others, may be attributable to an admixture of sound from the proximate air-vesicles.

3. VESICULAR RESPIRATION.—The sound incident to respiration heard over the chest elsewhere than upon the upper part of the sternum, at the sterno-clavicular junction, and in the upper part of the interscapular space near the spinal column, is called the pulmonary or vesicular respiration or murmur. Both terms imply that the sound is produced within the air-cells or vesicles of the lungs. This is not strictly true. The vesicular respiration is a mixed sound, being partly due to the air entering the cells, in part to the current traversing the bronchial tubes, and to some extent, probably, in certain parts of the chest, to transmitted tracheal respi-

ration. It is, however, true, that the predominant and distinguishing character of the vesicular respiration originates within the vesicles and capillary tubes. The expressions are therefore sufficiently appropriate, and the term vesicular is selected as the most distinctive, and the one generally adopted. This appellation originated with Andral.

In treating of the vesicular respiration, the facts of interest and importance in a practical point of view, will be found to relate mainly to 1. The characters which distinguish this variety of respiration from the tracheal and bronchial; 2. The variations in characters within the limits of health observed in different persons, and on examinations of corresponding situations on the two sides of the chest in the same person; 3. The different modifications presented in different regions on the same side.

The point first claiming attention is the first of the foregoing three divisions, viz., 'The characters which distinguish this variety of respiration from the tracheal and bronchial.' In considering this point, inasmuch as the vesicular respiration in every part of the chest is not in all respects identical, some region is to be selected as furnishing a type of this species of respiration. The region most convenient for this purpose is the summit of the left lung a little below the clavicle, midway between the acromial and sternal extremities. We will proceed, then, to institute a comparison between the characters of the vesicular respiration in the situation just mentioned, and those pertaining to the tracheal respiration. The tracheal respiration is selected in preference to the bronchial for the comparison, because, the contrast being stronger, the distinctive traits of the vesicular respiration are exhibited in bolder relief, and thereby rendered more clear and impressive.

On auscultating the summit of the left side, at the point mentioned, either immediately, or with the stethoscope, a sound more or less intense is generally found to accompany the inspiratory act. Comparing this sound with that heard over the trachea, it is found to present a striking difference in *quality*. Instead of being tubular, it has a quality difficult to describe, but which the student will readily appreciate on making the comparison practically. The words *soft*, *breezy*, *expansive*, are applied to it. It is compared to the slightly audible breathing heard at a little distance from a person in deep quiet sleep; to the sound produced by a gentle breeze among the branches and leaves of trees; to that of a pair of bellows the valve of which acts noiselessly; to softly sipping the air with the lips, etc. These comparisons are but rudely approximative, and are of little value, since it is so easy to become familiar with the sound itself by practising auscultation for a few moments on the chest and trachea alternately, of a healthy person, in whom the vesicular respiration is tolerably developed. This special quality it is convenient to designate the *vesicular quality*, an expression which will be frequently used in the following pages. The vesicular quality of respiration, as of percussion, is that peculiar kind of sound, not suggesting *à priori* to the mind the existence of cells, but due in a great measure, at least, to the cellular construction of the lungs. In what manner is this vesicular quality of sound generated? I shall not discuss this, more than other questions relating to the physical mechanism by which auscultatory phenomena are produced. It is generally attributed, after Laennec, to the friction and vibrations caused by the air driven into the cells by the inspiratory act. May not the peculiar quality be owing to the separation of the walls of the cells and capillary tubes, which, to a greater or less extent, come into contact, and, owing to the moisture of the tissues, are slightly adherent during the collapse of the lung incident to expiration? We shall see hereafter that this is the most rational explanation of an important and highly distinctive physical sign of disease. Whatever be the rationale, the distinctive quality of the vesicular respiration belongs to the inspiratory, and not to the expiratory sound.

The inspiratory sound is somewhat longer in duration than the tracheal. Like the tracheal it is continuous, augmenting in intensity from its commencement to its termination, and ending rather abruptly. It is decidedly lower in pitch than the tracheal inspiration.

According to Skoda, the average pitch of the vesicular inspiration may be represented by the consonant *v* or *b*, whispered.

In a certain proportion of instances, an expiratory sound is appreciable. This was the case in fifteen of twenty-four examinations; no sound of expiration being discovered in the remaining nine instances. In this respect the vesicular respiration presents a striking point of contrast with the tracheal, the act of expiration constantly developing a sound within the trachea. The difference is not less striking in other respects. The expiration, when present in the vesicular respiration, is nearly or quite continuous with the sound of inspiration; not succeeding after a brief, but distinct interval, as in the tracheal respiration. This statement holds good, except when the person examined, increasing voluntarily the force of the respiratory movements, holds the breath for an instant after completing the act of inspiration. The duration of the expiratory sound, considered relatively to that of the inspiratory, is much shorter than in the tracheal respiration. In the latter it is as long and not unfrequently longer than the sound of inspiration. In the vesicular respiration the expiratory sound is estimated by Fournet to average one-fifth the duration of the inspiratory. This estimate is perhaps not far from the truth,[1] but the relative duration varies considerably in different persons, in some being less than a fifth, in others a quarter, a half, and occasionally, but very rarely, except as an effect of disease, bearing a still larger ratio. The intensity, as compared with that of the inspiration, is much less. According to Fournet, numerically expressed, it is as much below that of the inspiration, as the duration is less, viz., one-fifth. The reverse of this rule obtains in the tracheal respiration. The pitch of the expiratory sound on the left side, certainly in the great majority of instances, is lower than that of the inspiratory. It is represented, according to Skoda, by a sound falling between the whispered consonants *f* and *h*. Here, too, the rule is the reverse of that which governs the tracheal respiration. In the latter, the pitch of the expiratory sound is usually higher than that of the inspiratory.

These, then, are the several points of contrast between the tracheal and the vesicular respiration; and it is to be borne in mind that precisely the same points of contrast exist between the vesicular and the bronchial respiration, the only difference being that in the latter case they are exhibited in a less striking degree. To recapitulate: the distinctive characters of the tracheal and the bronchial respiration on the one hand, and of the vesicular respiration on the other hand, as developed by the comparison just made, arranged in parallel columns are as follows:

TRACHEAL AND BRONCHIAL RESPIRATION.	VESICULAR RESPIRATION.
Inspiration.	*Inspiration.*
1. Tubular in quality.	1. Vesicular in quality.
2. In duration falling somewhat short of the inspiratory act.	2. Longer in duration.
3. High in pitch.	3. Low in pitch.

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[1] Barth and Roger and Walshe make the average duration greater, viz., one-third that of the inspiration. The mean duration might be obtained with accuracy, but it is not a matter of practical moment.

Expiration.	*Expiration.*
1. Uniformly present in tracheal respiration.	1. Absent in about one-third of the cases.
2. Generally more intense than the inspiration.	2. Intensity much less than that of the inspiration.
3. As long or longer than the sound of inspiration.	3. Much shorter than the sound of inspiration.
4. Higher in pitch than the inspiration.	4. Lower in pitch than the inspiration.
5. The inspiration and expiration separated by an interval.	5. The inspiration and expiration continuous.

As already stated, the foregoing points of contrast are applicable to auscultation in disease, for in connection with certain morbid conditions, it will be found that the vesicular respiration gives place to the tracheal or bronchial, and the latter then become physical signs of these morbid conditions.

The vesicular respiration presents marked differences in different persons, not only of the same age and sex, but apparently with chests similar in conformation. This statement is applicable not alone to the respiratory sounds pertaining to the summit of the left side, but to the thoracic regions in general. In intensity it is very far from being uniform. In some persons it is with difficulty appreciable, and in some cannot be heard even when the force of the respiration is voluntarily increased. In others it is loudly developed. Between these extremes there is every grade of intensity. In the same person the murmur often differs considerably in intensity with different respirations, with some being perhaps full and loud, while with others it is feeble, and sometimes inappreciable, these fluctuations being observed in the space of the few moments that the ear is applied to the chest. In pitch and quality of sound the respirations in the same person appear to be identical, whether feeble or intense; and forced respiration compared with tranquil breathing, do not show any change except in an increased intensity. It is heard with greater intensity by immediate, than by mediate auscultation, provided the ordinary cylinder be employed; but with Cammann's stethoscope, the intensity is much greater than when the ear is placed in direct apposition to the chest. It may be distinctly appreciated with Cammann's stethoscope, when it is not heard with the ordinary cylinder or the naked ear. The expiratory sound, which, as has been seen, is present in some persons and absent in others, varying also in its relative duration, is sometimes discovered by immediate auscultation, when it is not heard with the cylinder; and in some instances may be rendered distinct by Cammann's instrument, when it is inappreciable by the ordinary stethoscope or the ear alone. My recorded examinations of healthy chests contain illustrations of these facts. Sex and age exert a decided influence on the intensity of the vesicular respiration. In early life the intensity is marked, so that a morbidly intense vesicular murmur, after Laennec, is frequently distinguished as *puerile* respiration. In old age, on the other hand, the intensity is diminished, a change to be attributed, according to Andral, to the attenuation of the walls of the air-cells which attends advanced years. At the same time the expiratory sound becomes relatively more developed and longer. The respiration thus modified by age is distinguished as *senile* respiration. In females, as a general remark, the respiratory sounds are more intense than in males. This is true more especially of the vesicular respiration at the summit of the chest.

In other respects than intensity, differences are to be observed in the respiratory sounds in different persons. The degree of vesicular quality and the pitch are not uniform. Auscultating a number of persons in succession, in no two perhaps will the murmur, as regards these characters, be identical.

These diversities do not impair the usefulness of auscultation, more than a similar want of uniformity in the phenomena developed by percussion affects the latter method of exploration; because in both instances, deviations from health are not determined by reference to any fixed, abstract standard, as regards intensity, pitch, etc., but, generally, by a comparison of the two sides of the chest.

The expiratory sound, as already intimated, differs from the inspiratory not only in duration, intensity, and pitch, but in quality. It is devoid of the vesicular quality which characterizes the inspiratory sound, and is feebly tubular or blowing, resembling the tracheal in quality, but differing in its want of intensity and lowness of pitch. It remains to consider the variations in characters of the vesicular respiration observed on comparative examinations of corresponding situations on the two sides of the chest in the same person; and the different modifications presented in different regions on the same side.

Comparing first the two sides, the summit of the chest claims attention more especially, because slight deviations from correspondence in this situation are of great importance in their bearing on the diagnosis of tuberculous disease; and, moreover, anatomically, there is greater equality at the upper part of the chest, than at the middle or lower portion, in consequence of the presence of the heart and other organs, which encroach more or less on the thoracic space, rendering the two sides more or less unequal. Besides, the diseases seated in the lower and middle portions, pneumonia, pleurisy, etc., do not generally require so nice a comparison of the two sides as is frequently involved in the diagnosis of tuberculous disease, which affects by preference the superior part of the lungs. For the reasons just stated, the question in how far the two sides of the chest are in unison as respects the phenomena developed by auscultation, has an important practical relation, and it is highly desirable to determine what points of disparity may occur in this situation within the limits of health, in order that they may not be mistaken for the signs of disease. It is stated by Fournet as a conclusion based on repeated examinations of the chest in persons apparently free from thoracic disease, that the respiratory sounds at the summit on the two sides are absolutely identical, and hence, that any disparity is a just ground for assuming the existence of disease.[1] The observations of others have shown this conclusion to be erroneous. Dr. Gerhard,[2] of Philadelphia, was the first to direct attention to the frequent existence of disparity between the two sides, consisting, according to him, in a greater intensity of the respiratory sound on the right side, which he attributed to the larger size and relative shortness of the right primary bronchus. Subsequently M. Louis, in a series of examinations of persons free from pulmonary disease, found a certain proportion of instances in which an expiratory sound exists on the right side and not on the left; and that when it exists on both sides it is often more intense and prolonged on the right side. In the twenty-four examinations to which I have already referred, attention was paid, among other points, to the one under consideration; and an analysis of the phenomena recorded at the instant of observation, shows differences between the two sides of the summit in intensity, the amount of the vesicular quality, and the pitch of the inspiratory sound, as well as in the relative development, duration, and pitch of the sound of expiration. The results of the analysis are as follows:

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[1] "J'ai choisi, dans des salles de militaires ceux qui avaient toutes les apparences de la santé la plus robuste, et qui avaient été amenés à l'hôpital par des maladies tout-à-fait étrangères aux organes thoraciques; j'ai bien constaté chez eux qu'en effet, dans l'état normal, les bruits respiratoires se faisaient entendre absolument égaux de l'un et de l'autre coté. Il resulte de là que *toutes les fois qu'une différence existera entre les bruits des deux sommets de la poitrine, cette différence pourra, en règle générale, être attribuée à une état pathologique.*"—*Recherches sur l'Auscultation, etc.* t. 1, p. 64. The italics are the author's. Walshe also says, "The characters of the inspiration-sound do not differ in the corresponding points of the two sides of the chest to any appreciable amount." Ed. of 1854, page 93, English Ed.

[2] The Diagnosis, Pathology, and Treatment of the Diseases of the Chest, by W. W. Gerhard, M.D., etc., 1846.

1. *Inspiratory Sound.*—In sixteen of twenty-four cases, more or less difference as respects *intensity* between the two sides was appreciable. In all but one of these sixteen instances the inspiratory sound was more intense on the left side. This result is in direct opposition to the statements of some authors;[1] but the matter is purely one of observation, and as the comparisons were made with care, and with no expectation of ariving at such a result, I am bound to assume its correctness. I can only account for the opinion of observers that the inspiratory sound on the right side is frequently more intense than that of the left, by supposing that elevation of pitch has been mistaken for increased intensity. The disparity in intensity was in some instances very marked. An inspiratory murmur was occasionally tolerably developed on the left side, and scarcely audible on the right. A striking difference was also in some cases observed in the effect of forced respiration on the intensity of the inspiratory sound, the intensity on the left side being proportionately increased, without any augmentation on the right side.

In the relative amount of vesicular quality a difference was appreciable in a large proportion of the cases. And in all the instances in which a disparity in this particular existed, the greater amount of vesicular quality was on the left side. This was true in fourteen of twenty-four examinations of different individuals. The disparity in some instances was slight, but in several strongly marked; in not one instance was the vesicular quality greater on the right side.

Compared as respects the pitch of the inspiratory sounds, a difference was apparent in a large majority of the observations. Excluding a few cases in which attention was not directed to this point, of nineteen examinations, the pitch was higher on the right side in twelve, and no disparity was appreciable in seven; in not a single instance was the pitch higher on the left side. The difference here as with respect to the preceding characters, was in some instances striking, and in other instances slight. This numerical result does not vary much from that obtained by an analysis of the series of previous examinations. The latter numbered fifteen, and of these fifteen examinations the inspiratory murmur was higher in pitch

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[1] Gerhard, Barth and Roger.

Comparison of Right and Left Lower Scapular Regions. Number of Examinations twenty.

INSPIRATION.

Absent on both sides in 1 case. Too indistinct to compare in 4 cases.

Right.	*Left.*
More intense in 2 cases.	More intense in 8 cases.
Vesicular quality more marked in no case.	Vesicular quality more marked in 6 cases.
Pitch higher in 7 cases.	Pitch higher in no case.

EXPIRATION.

Presence noted in 7 cases.

Right.	*Left.*
Present only on this side in 4 cases.	Present only on this side in no case.
More intense than inspiration in 3 cases.	More intense than inspiration in no case.
Higher in pitch than inspiration in 4 cases.	Higher in pitch than inspiration in no case.
Noted lower in pitch than inspiration in 1 case.	Noted lower in pitch than inspiration in 3 cases.

These results correspond with those presented in the previous tables. The inspiratory sound is oftener more intense and more vesicular on the left side, but wherever a disparity in pitch is observable, it is higher on the right side. An expiratory sound is sometimes present on the right, and not on the left side. The reverse is not observed. It is sometimes more intense than the sound of inspiration on the right side, but this does not occur on the left side. It is generally higher in pitch than the sound of inspiration on the right side, and this does not occur on the left side; on the other hand, it is distinctly lower in pitch in some instances on the left side, and rarely on the right side. In short, irrespective of disparity between the two sides as regards intensity, the respiratory sound on the right side presents in a certain proportion of cases more or less of the characters of the bronchial respiration.

The differences between the two sides of the chest at the summit, in front and behind, compatible with a healthy condition of the thoracic organs, which, as already intimated, have not escaped the attention of observers, are generally attributed to the difference in size, length, and direction between the two primary bronchi. Fournet denies that this difference is sufficient to occasion any disparity in the auscultatory phenomena. But he also denies the fact of the existence of any disparity between the two sides as respects these phenomena. Other causes may be involved, but that the one just mentioned, if not in itself adequate to account for the disparity, is more or less concerned in its production, is rendered pro-

Comparison of Right and Left Infra-clavicular Regions. Whole number of examinations twenty-four.

INSPIRATORY SOUND.

Right.	*Left.*
Greater intensity in 1 case.	Greater intensity in 15 cases.
Vesicular quality more marked in no case.	Vesicular quality more marked in 14 cases.
Higher pitch of sound in 12 of 19 examinations.	Higher pitch of sound in no case.

EXPIRATORY SOUND.

Right.	*Left.*
Present on this side, and not on left side, in 3 cases.	Present on this side, and not on right side, in no case.
More intense on this side in 2 cases.	More intense on this side in no case.
Prolonged in several cases.	Prolonged in none.
An interval between the sounds of inspiration and expiration in several cases.	The two sounds continuous.
Pitch higher than that of the inspiratory sound in 11 instances.	Pitch higher in 1 instance.
Pitch lower than that of inspiration in 4 instances.	Pitch lower in 10 instances.

Reviewing the facts pertaining to both the inspiratory and the expiratory sound, it is perceived that the several elements which have been seen to compose the bronchial respiration are manifested at the summit of the chest, in front, on the right side. This is a practical conclusion arrived at by means of the foregoing analysis. Assuming this conclusion to be correct, its importance will be apparent hereafter, in connection with the diagnosis of tuberculosis of the lungs in the early stage. In that connection, without knowledge of the facts which have been presented, it can hardly be otherwise than that error of diagnosis will be committed, by mistaking for the physical signs of disease, the several characters of the bronchial respiration which may exist at the summit of the right chest, not proceeding from a morbid condition. I am free to state that my own experience would supply illustrations of error from this source.

The *post-clavicular region* may be examined by auscultation, the stethoscope being requisite in this situation. The caution inculcated by Laennec, is important to be borne in mind in applying the stethoscope above the clavicle, viz., to avoid pressing the instrument in a direction toward the trachea. The tracheal sounds are liable to be conducted to the ear if attention be not paid to this point. Pressure of the stethoscope in this region may develope an arterial *bruit* which is to be distinguished from a respiratory sound by observing that it is synchronous with the pulse, and persisting when the movements of respiration are voluntarily arrested. The vesicular respiratory sound is readily discovered in the post-clavicular region if it be tolerably developed below the clavicle in the person examined. With respect to a comparison of the two sides, I have not noted observations. In a single instance in which the phenomena were recorded, care being taken not to incline the stethoscope toward the trachea, the inspiratory sound was more intense on the left side, and no sound of expiration appreciable on that side; but on the right side, after an interval, a well-marked expiratory succeeded the inspiratory sound, and higher in pitch.

Passing, next, to the upper portion of the chest behind, over the *scapula above the spinous ridge*, owing to the difficulty of applying the ear directly, the stethoscope is preferable. With the wooden cylinder a respiratory sound is heard sufficiently to study its characters and institute a comparison between the two sides in only a certain proportion of cases. With Cammann's instrument it is sometimes rendered distinct when it is scarcely appreciable with the ordinary stethoscope. This instrument was used by me here, as in other situations, in but a portion of the examinations made with a view to study the phenomena incident to auscultation in health. The results developed by the analysis of these observations would probably have been to some extent different had it been uniformly employed in conjunction with immediate auscultation, and the use of the wooden cylinder. The facts pertaining to the respiratory sounds in the upper scapular region on the two sides contained in twenty-one examinations are exhibited in the following table:

Comparison of Right and Left Upper Scapular Regions.

INSPIRATION.

Absent on both sides in 5 cases.

Right.	*Left.*
Sound indistinctly appreciable in 7 instances.	Sound indistinctly appreciable in 10 instances.
Intensity greater in 1 case of 7, in which the sound was more or less developed by forced respiration.	Intensity greater in 3 cases.
Pitch higher on this side in 2 cases.	Pitch higher in no case.
Vesicular quality more marked in no case.	Vesicular quality more marked in 2 cases.

EXPIRATION.

Right.	*Left.*
Expiratory sound, absent in 7 cases.	Expiratory sound absent in 10 cases.
Indistinctly appreciable in 4 cases.	Indistinctly appreciable in 5 cases.
Prolonged in 5 out of 6 examinations made with respect to this point.	Prolonged in no case.
More intense than the sound of inspiration, and higher in pitch in 5 cases.	More intense than sound of inspiration and higher in pitch in 1 case.[1]

It follows from these results that while an inspiratory sound is absent on both sides in an equal proportion of cases, viz., about one-third, the sound of expiration is oftener absent on the left than on the right side; both the inspiratory and expiratory sounds are oftener very feeble on the left side, but when tolerably developed the inspiratory sound on the left side is apt to be more vesicular and more intense than on the right, while the latter is apt to be higher in pitch; and the sound of expiration on the right side in a certain proportion of instances is prolonged, more intense than the inspiratory, and higher in pitch, this being very rarely the case on the left side. According to these results the disparity frequently existing between the two sides, corresponds with that observed at the summit and in front. More or less of the elements of the bronchial respiration, in other words, are occasionally manifested on the right side.

The respiratory sounds when heard over the upper scapular region are not only less intense than in front of the summit of the chest, but the vesicular quality is less marked, and they convey to the mind the impression of greater distance from the ear.

In examining the *scapular region below the spinous ridge*, immediate auscultation is available. A respiratory sound is appreciable here in a larger number of instances than above the ridge, and is more intense when present in both situations. It is, however, considerably less intense in the cases in which it is fully developed than in the infra-clavicular region. Here, also, as above the spinous ridge, the vesicular quality is less marked, and the sound seems farther removed from the ear. An analysis of the observations recorded with reference to a comparison of the two sides gives the results exhibited in the following table:

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[1] In this case the contrast with the inspiration in these respects, was less than on the right side in the same case.

Comparison of Right and Left Lower Scapular Regions. Number of Examinations twenty.

INSPIRATION.

Absent on both sides in 1 case. Too indistinct to compare in 4 cases.

Right.	*Left.*
More intense in 2 cases.	More intense in 8 cases.
Vesicular quality more marked in no case.	Vesicular quality more marked in 6 cases.
Pitch higher in 7 cases.	Pitch higher in no case.

EXPIRATION.

Presence noted in 7 cases.

Right.	*Left.*
Present only on this side in 4 cases.	Present only on this side in no case.
More intense than inspiration in 3 cases.	More intense than inspiration in no case.
Higher in pitch than inspiration in 4 cases.	Higher in pitch than inspiration in no case.
Noted lower in pitch than inspiration in 1 case.	Noted lower in pitch than inspiration in 3 cases.

These results correspond with those presented in the previous tables. The inspiratory sound is oftener more intense and more vesicular on the left side, but wherever a disparity in pitch is observable, it is higher on the right side. An expiratory sound is sometimes present on the right, and not on the left side. The reverse is not observed. It is sometimes more intense than the sound of inspiration on the right side, but this does not occur on the left side. It is generally higher in pitch than the sound of inspiration on the right side, and this does not occur on the left side; on the other hand, it is distinctly lower in pitch in some instances on the left side, and rarely on the right side. In short, irrespective of disparity between the two sides as regards intensity, the respiratory sound on the right side presents in a certain proportion of cases more or less of the characters of the bronchial respiration.

The differences between the two sides of the chest at the summit, in front and behind, compatible with a healthy condition of the thoracic organs, which, as already intimated, have not escaped the attention of observers, are generally attributed to the difference in size, length, and direction between the two primary bronchi. Fournet denies that this difference is sufficient to occasion any disparity in the auscultatory phenomena. But he also denies the fact of the existence of any disparity between the two sides as respects these phenomena. Other causes may be involved, but that the one just mentioned, if not in itself adequate to account for the disparity, is more or less concerned in its production, is rendered probable by the following experiment: The larynx, trachea, and primary bronchi, with some of the larger subdivisions of the latter extending an equal length on each side, were detached from the pulmonary organs and removed from the body. Then by means of a large pair of bellows, the nozzle of which was inserted into the larynx and secured by a ligature, a current of air was made to traverse the bronchial tubes first on one side and afterward on the other side by compressing alternately the right and the left bronchus with the finger. Comparing the sounds thus produced, which were quite loud, it was very obvious that the sound produced by the current of air driven through the right bronchus and its subdivisions was more intense and higher in pitch than that produced within the left bronchial tubes; care being taken to place the two bronchi as nearly as possible in their natural position as regards their angular relation to the trachea. This experiment was repeated numerous times in the presence of several medical gentlemen, and also in the lecture room before a large class of medical students. The disparity just stated was not less obvious to others than to myself. When the current was made to traverse the bronchial tubes on both sides simultaneously, it was easy to perceive a difference in intensity and pitch on bringing the ear in close proximity to the bronchial tubes first on one side, and then on the other side.

The result of this experiment may seem at first to be inconsistent with the fact that the inspiratory sound on the left side is frequently more intense than that on the right side. It is, however, to be borne in mind, that it is the sound produced within the vesicles on the left side which is more developed than on the right side. The respiration on the left side presents a more marked vesicular quality, at the same time that its intensity is in some instances greater. The latter, then, it is fair to conclude, is due to some cause connected with the air-cells, and not with the bronchial tubes.

In the infra-scapular region a respiratory sound is almost uniformly appreciable. It is generally well developed, and frequently with forced breathing becomes intense. Here, as in other situations, a very marked difference in intensity is often observed between the sounds developed by ordinary and forced breathing: with the latter, in some instances, they are quite loud, when with the former they may be scarcely heard. As a general rule, the intensity is greater than in the lower scapular region; the vesicular quality is also more apparent, and the pitch somewhat lower. This rule is not without exceptions. The intensity in a small proportion of instances is about equal in the scapular and infra-scapular regions; so, also, the vesicular quality and pitch. In one of the examinations which I have noted, the intensity was in a marked degree greater below, than over the scapula. The person examined was a female.

The subjoined table exhibits the results of a comparison of the two sides as respects the respiratory sound observed in this region.

Comparison of the Right and Left Infra-scapular Regions.

INSPIRATION.

Present in all of 21 examinations.

Right.	*Left.*
More intense in 1 of 14 examinations.	More intense in 5 of 14 examinations.
Vesicular quality more marked in none of 11 examinations.	Vesicular quality more marked in 2 of 11 examinations.
Pitch higher in 4 of 13 examinations.	Pitch higher in none of 13 examinations.

EXPIRATION.

Of 17 examinations present in 5 and absent in 12.

Right.	*Left.*
Present only on this side in 1 of 5 cases.[1]	Present only on this side in 1 of 5 cases.

The variations between the two sides are decidedly less frequent and marked in this situation than in the regions before compared. In a few instances the intensity is greater on one side, and when this is the case, the greater intensity is almost uniformly on the left side. Occasionally the vesicular quality is more marked on the left side, and in a few instances the pitch is higher on the right side.

The expiratory sound is almost uniformly lower in pitch than the sound of inspiration. A single exception to this rule was noted on the right side, and in this instance the sound was distant, an intense expiratory sound existing over the scapula on the same side. This case shows that it is possible for the tracheal or bronchial respiratory sounds to be transmitted in the healthy chest to the ear applied below the scapula,—a fact important to be remembered, since these sounds in that situation in the vast majority of cases is evidence of disease.

Passing to the front of the chest, it will suffice to notice the respiratory phenomena furnished by auscultation in the *mammary and infra-mammary regions* under the same head.

An inspiratory sound is almost uniformly appreciable in these regions, but differing considerably in intensity in different individuals.

[1] In this case it is noted that the sound was distant and high in pitch; an intense expiratory sound existed in that case over the scapula.

Of 23 recorded examinations in which more or less of the respiratory phenomena were noted, in no instance was an inspiratory sound inappreciable. Instances, however, are occasionally met with. The intensity is less than at the summit, with very few exceptions. This was true in all but two of sixteen observations made relative to this point. In one of these two instances the greater development in the mammary region was confined to the right side; and in the other instance the inspiratory sound at the summit was extremely feeble. The pitch is uniformly lower. Of eighteen observations this was true without an exception. The vesicular quality is, at the same time, more marked. The latter, and lowness of pitch, are correlative traits. In these three points of view, viz., diminished intensity, lowness of pitch, and more marked vesicular quality, the difference on comparison with the summit of the chest is sometimes greater on one side of the chest than on the other side. This fact is noted in several instances. It is to be explained by the disparity which has been seen to exist at the summit in a certain pr6portion of individuals as regards intensity, pitch, and vesicular quality. Supposing the inspiratory sounds at the middle and lower portions of the chest to be equal, a comparison with the sounds at the summit will, of course, not give identical results if the two sides at the summit differ. Another explanation, applicable to a certain extent in some instances, is, that the sounds over the middle and lower portions on the two sides are not equal. The latter is true, but of a very small proportion of cases save with respect to intensity. Of twelve comparisons of the two sides, in five the intensity appeared somewhat greater on the left, and in two on the right side. With a single exception, in which the pitch appeared a little higher on the right side, there was no disparity in pitch or vesicular quality between the two sides. In the course of my examinations I attempted in several instances to determine whether there was an appreciable difference in the pitch, intensity, or vesicular quality of the inspiratory sound over the upper lobe on the left side, or the middle lobe on the right side, and the small portion of the lower lobe extending in front. I endeavored, in other words, to define the situation of the interlobar fissure by a change in the vesicular murmur. In one instance, and one only, I appeared to succeed. In that instance the person was a good subject for this experiment, the vesicular respiration being unusually well developed. Passing the stethoscope downward on a vertical line falling about half an inch within the nipple, on the left side, between the fourth and fifth ribs, the characters of the inspiratory sound abruptly changed, the pitch especially becoming lower, and the intensity lessened. The same abrupt change was discovered on the right side.

An expiratory sound is very rarely appreciable in the mammary and infra-mammary regions. Its presence is noted in two only of thirteen examinations, the records of which contain information on this point. In one of these two cases it was only appreciable with Cammann's instrument, not by immediate auscultation, or the ordinary stethoscope. The number of instances in which it was appreciable would have perhaps been greater had Cammann's instrument been employed in a larger proportion of the examinations. It was used in a little less than one-half of the cases only. In both instances in which an expiratory sound was present, the pitch was distinctly lower than that of the inspiratory.

It is unnecessary to introduce a table exhibiting the results of a comparison of the two sides of the chest, as respects the respiratory phenomena, observed in the mammary and infra-mammary regions, for the disparity noted, as has been seen, with a single exception, consists in a greater intensity of the vesicular murmur on the left side in a certain proportion of cases, and on the right side in a smaller proportion.

In the *axillary and infra-axillary regions*, an inspiratory sound, especially with forced breathing, is often heard with as much and even more intensity than over any other part of the chest: of thirteen examinations, in none was the respiratory murmur absent. Its absence, however, in these regions would not necessarily denote disease more than in other situations where it is generally present. It may be inappreciable in healthy chests, in some instances, for reasons that are apparent, as when the thorax is covered with a very thick layer of adipose deposit; and in other instances when no cause is apparent and it can only be attributed to a peculiarity of constitution. As in other situations the intensity differs considerably in different persons. The intensity is generally less in the infra-axillary, than in the axillary region, and the pitch somewhat lower. Careful comparison of the two sides, according to my observations, shows some points of disparity in the larger proportion of cases. Thus, of twelve examinations, in five no difference was apparent, and in seven there existed more or less inequality. The facts respecting the disparity in the seven cases in which it was noted, are as follows: the intensity was greater on the left side in three cases, and on the right side in three cases. The pitch was higher in four cases, all on the right side. The vesicular quality was more marked in three cases, all on the left side.

An expiratory sound is heard in a much larger proportion of instances than over the middle and lower portions of the chest in front or behind. Of nine examinations its presence is noted in five, and its absence in four. It was present in the axilla in some instances and not in the infra-axillary region. It was lower in pitch than the inspiratory sound save in one instance, and in this instance it was higher on the right side and lower on the left.

II. PHENOMENA INCIDENT TO THE VOICE.

The phenomena produced in health by the act of speaking, like those incident to respiration, differ in different portions of the respiratory apparatus; and the vocal, as well as breathing sounds may be arranged according to their situation, into 1st, those produced within the larynx and trachea; 2d, those heard over the large bronchi; and 3d, those emanating from the chest generally. The healthy phenomena in these several situations incident to the voice, not less than those developed by respiration, represent sounds which, by a change of place, become the signs of disease. The more important of the vocal phenomena pertaining to morbid conditions may, in fact, be studied upon the healthy living subject. Moreover, here, as in the case of the respiratory phenomena, variations within the limits of health exist in different individuals, and in the same individual in corresponding regions of the two sides of the chest, which, without due knowledge and care, are liable to be mistaken for the evidences of disease, giving rise, possibly, to serious errors of diagnosis. The study of the phenomena incident to the voice in health, therefore, merits close attention, preparatory to entering on the subject of auscultation in disease.

In auscultating for vocal sounds, in health and disease, the ear may be applied immediately to the chest, or the stethoscope may be employed. In general, the sounds are better appreciated and are more intense with the naked ear than with the ordinary stethoscope, and the latter is not only useless, but disadvantageous, except when it is desired to concentrate the examination upon a circumscribed space, or direct it to parts of the chest to which the ear cannot be satisfactorily applied. In listening to vocal phenomena with the ear alone, or with the cylinder, the sounds are heard better if the unoccupied ear be closed completely by pressure with the finger. By means of Cammann's stethoscope the sounds produced by the voice, are rendered much more intense than by ordinary mediate or immediate auscultation. Phenomena are made distinct by this instrument, in some instances, in which without it they are too feeble to be appreciated. The general rules and precautions to be observed in the practice of auscultation are alike applicable to the investigation of vocal and respiratory phenomena. These need not be repeated. We may cause the patient to speak by addressing to him questions while the ear is applied to the chest; but a better mode is to request him to count in a distinct and tolerably loud voice, directing him to pronounce each numeral as nearly as possible with the same tone, distinctness, and degree of loudness, pausing a little between the numbers. It is also desirable often to observe the effect of articulating in a whisper.

In treating of the auscultation of the voice in health, I shall adopt the same divisions as in treating of the respiratory sounds, and consider under distinct heads the tracheal voice (including the laryngeal), the bronchial voice, and the normal vesicular vocal resonance. And I shall present under these general divisions of the subject the results of analysis of observations made in a certain number of persons supposed to be free from diseases affecting the respiratory organs, in the manner pursued in treating of the phenomena incident to respiration. It is evident that upon results thus obtained must be based accurate knowledge of the phenomena pertaining to, and compatible with, a condition of health; and this knowledge, it is equally evident, is the true point of departure for determining morbid signs by clinical observations.

1. TRACHEAL VOICE; (LARYNGEAL VOICE; TRACHEOPHONY; LARYNGOPHONY).—If the stethoscope be placed over the trachea just above the sternal notch, and the person desired to count in a moderately loud tone, the ear of the auscultator receives a combination of sensations resolvable into several different elements. The voice occasions a strong resonance, accompanied by a concussion or shock, and, also, by a fremitus or thrill. The articulated words are sometimes transmitted so as to be heard almost as clearly as when received from the lips; in other instances they are conveyed with more or less indistinctness, and occasionally are inappreciable. The resonance, the shock, the fremitus, and the complete or incomplete transmission of sounds

are the several elements which compose the mixed sensations embraced under the head of the tracheal voice. It will facilitate a clear apprehension of the vocal phenomena incident to the auscultation of different parts of the respiratory apparatus, and not less to morbid conditions, to consider the tracheal voice as thus made up of different constituents. All these elements, in the great majority of instances, will be found to enter into the tracheal voice, the differences in different individuals consisting in variations in the degree, absolute and relative, which they present. The resonance and shock and fremitus are generally strong. Of twenty-two examinations it is noted that these elements were strongly marked in eighteen ; considerably so in three, and moderate in one only.

These three elements, as a general remark, appear to preserve a mutual relation ; that is to say, they participate about equally in the variations, as regards intensity, observed in different individuals. Yet they do not involve precisely the same physical causes. The resonance is due to the reverberation of the voice within the tracheal space ; the shock to the force given to the column of air by expiration in connection with its partial, sudden arrest by the act of speaking, and the fremitus to the vibrations of the tracheal tube, in conjunction with those of the vocal chords. Collectively, they are more strongly marked in proportion to the strength of the voice, and its gravity of tone. Hence, in females and children, they are comparatively less prominent. If Cammann's stethoscope be applied over the trachea, the shock and resonance are felt with a painful intensity, in some instances being quite unendurable; the articulated voice, however, is not conducted much better through this instrument than through the ordinary cylinder.

The transmission of sounds more or less perfectly through the stethoscope is an interesting and important element of the tracheal voice, from the fact that when it occurs over the chest, as incident to disease, it constitutes the physical sign called *Pectoriloquy*. Pectoriloquy is said to be perfect when the articulated sounds are distinctly heard with the ear applied to the chest mediately or immmediately. It is imperfect when the words are indistinctly heard. The types of perfect, and the various grades of imperfect pectoriloquy, are furnished by auscultation of the trachea. Hence, by becoming practically acquainted with this element of the tracheal voice, the student acquires, at the same time, an acquaintance with a morbid sign, the significance of which will be hereafter considered. The proportion of cases, however, in which perfect pectoriloquy is represented by the tracheal voice is small. Of twenty-three examinations the articulated voice was distinctly transmitted in only four; being more or less indistinctly appreciable in the remaining nineteen. The degree of indistinctness varied considerably in the nineteen cases. It is evident from these results that the transmission of the articulated voice is quite independent of the preceding elements, viz., the resonance, shock, and thrill. This want of relation is further shown by the fact that a powerful and base voice, which is most favorable for the elements just mentioned, does not render the pectoriloquous element more strongly marked. A clear sharp voice is probably best transmitted, but I have not noted observations with respect to that point. The foregoing vocal phenomena referable to the trachea are those which are occasioned by the voice when words are spoken aloud. When words are whispered there is little or no resonance, shock, or thrill. These three elements are either wanting, or comparatively slight; but the whispered words are transmitted in some instances perfectly, and in other instances incompletely. This is identical with what is called whispering pectoriloquy, when whispered words are received from any portion of the chest. The term pectoriloquy cannot of course, with strict propriety, be applied to the trachea, because its signification implies that the voice comes from the chest. From its derivation it signifies chest-talking. In connection with perfect or incomplete transmission of speech is a strongly marked *souffle* or blowing sound. The latter follows the vocal sound, and appears as if a current of air were directed into the ear through the stethoscope. This *souffle* or blowing sound is also appreciable in some instances when words are spoken aloud. Its intensity is irrespective of the perfect transmission of the articulated voice. It is sometimes intense when the transmission of the voice is quite imperfect. Whispered words are oftener distinctly transmitted than words spoken aloud. Of twenty observations the transmission was perfect in five, in three it was quite imperfect, and in twelve, although not perfect, it was less imperfect than when the words were spoken aloud.

If the stethoscope be placed on the broad surface of the thyroid cartilage, the vocal phenomena emanating directly from the larynx will be found to be resolvable into the same elements as are those proceeding from the trachea. The laryngeal voice, does not present the marked differences, compared with the tracheal, which the student is led to expect from the writings of some authors; and in some instances, the sounds in both situations are very nearly if not quite identical. As a general rule, the shock and vibration communicated to the ear are less than when auscultation is practised over the trachea. There are some exceptional instances in which they are of the same intensity, but very rarely, if ever, greater. The transmission of the articulated voice is oftener perfect, and generally less incomplete. Of eighteen comparisons with reference to the latter point, in no instance was the pectoriloquous element more marked over the trachea; in six instances there was no obvious difference between the tracheal and laryngeal voice in this particular, and in twelve instances the transmission was decidedly more complete over the larynx.

2. Bronchial Voice; Normal Bronchophony.—Applying the stethoscope, or the naked ear, to the chest at the points where the normal bronchial respiration is to be sought for, viz., in front near the sterno-clavicular junction, and behind, in the interscapular space, on a line with the spinous ridge of the scapula, the phenomena attendant on the act of speaking constitute what is distinguished as the bronchial voice, or normal bronchophony. It differs greatly from the tracheal voice or tracheophony, but the difference consists mainly in the characters of the latter being but partially present, and with a much less degree of intensity. A certain amount of resonance characterizes the bronchial voice, and this varies considerably in its intensity in different persons. In some persons it is quite strong, in others almost inappreciable, and it may present every grade of intensity between these extremes. Other things being equal, it is stronger in proportion to the power of the voice and gravity of its tone. It is better appreciated and its intensity is greater by immediate than by mediate auscultation. It is rarely, if ever, the case that the ear receives a shock or concussion, such as is felt when the stethoscope is placed over the trachea. A fremitus or thrill is either absent, or, if present, is generally slight; but in some instances it is well-marked. The articulated voice is very rarely transmitted. Whispering pectoriloquy exists in a small proportion of cases. The results of an analysis of fifteen observations relative to the transmission of the voice are, that in nine instances pectoriloquy, perfect or imperfect, did not exist; in but one instance were spoken words conveyed to the ear,

and in this instance in the interscapular space only; in two instances whispering pectoriloquy was perfect, and in three instances imperfect. A *souffle* or blowing sound was observed in some instances to accompany the utterance of words spoken aloud, and in a large proportion of instances whispered words. These, then, are the characters of normal bronchophony contrasted with tracheophony: A resonance less in degree, and differing widely in different persons; absence of shock or concussion; a fremitus or thrill present in a certain proportion of cases, and less marked; words spoken aloud transmitted only as an occasional exception to the general rule, and whispering pectoriloquy, perfect or imperfect, existing in a small number of instances.

Comparing the two sides of the chest in front and behind, an obvious disparity exists in a large majority of cases. This is seen by the following table giving the results of a series of observations relative to this point:

Comparison of the Right and Left Side of the Chest, as respects Normal Bronchophony.

FRONT.

Right.	*Left.*
Resonance greater in 19 of 23 examinations.	Resonance greater in none of 23 examinations.

BACK.

Right.	*Left.*
Resonance greater in 13 of 22 examinations.	Resonance greater in none of 22 examinations.

It thus appears that excepting a very small proportion of instances the vocal resonance is greater on the right side in front, and in a ratio of more than one-half it is greater behind, while a greater degree of resonance is never observed on the left side either in front or behind. In some instances a resonance exists on the right side and none is appreciable on the left. This was observed in two instances in front, and in two instances behind. The difference between the two sides in the cases in which it was perceived on both, was sometimes slight, but in some instances strongly marked. It was generally more apparent on immediate auscultation, than with the ordinary cylinder; and was rendered still more apparent by Cammann's stethoscope.

3. NORMAL VESICULAR VOCAL RESONANCE.—I adopt the title *vesicular vocal resonance* to distinguish the sound occasioned by the

voice when the ear is applied over the chest elsewhere than at the situations where the bronchial voice, as well as the normal bronchial respiration, is to be sought for, viz., at the upper part of the interscapular space behind, and near the sterno-clavicular junction in front. The title is to be preferred, not so much from its intrinsic appropriateness, as for the sake of uniformity, the respiratory sounds heard over the chest, with the exception just mentioned, being called *vesicular.* The vocal sounds cannot with strict propriety be called vesicular, inasmuch as the air-vesicles have no agency in their production. In its present application the term simply denotes that the sound is that heard over all those portions of the chest beneath which the air-vesicles predominate over the bronchial tubes, obstructing the transmission of the sonorous vibrations, which may be either conducted by the latter from the larynx, or possibly reproduced within them. The same objections are applicable equally to the term *pulmonary*, which by some writers is used to distinguish the vesicular respiration.

The vesicular vocal resonance presents important distinctive traits when contrasted with the tracheal or bronchial voice, more especially the former; certain differences are frequently observed when corresponding regions on the two sides of the chest are compared, and the effect produced by the act of speaking in different portions of the same side are not identical. The vesicular vocal resonance is to be considered under these three points of view.

First, as contrasted with tracheophony and normal bronchophony, the vesicular resonance is generally much weaker; in other words, it has much less intensity. It differs from the former, especially, in not being constantly present; not unfrequently over portions of the chest no resonance is appreciable, at least with the ordinary stethoscope, and immediate auscultation; and in some persons it is absent over the entire chest. The sound, in general, seems farther removed from the ear. It is rarely accompanied by a sense of concussion or shock. It is less frequently attended by fremitus or thrill, but in some instances, in certain parts of the chest, the latter concomitant is strongly marked; and it is sometimes present in a degree which is out of proportion to the amount of resonance. Transmission of the articulated voice, in other words pectoriloquy, does not occur in connection with normal vesicular resonance, save as a very rare anomaly. Imperfect whispering pectoriloquy is occasionally observed; and not very unfrequently, in some parts of the chest, the act of speaking in a whisper occasions a *souffle* or blowing sound, resembling that which attends the tracheal and the bronchial voice. These are the important points distinguishing the phenomena embraced under the appellation of the normal vesicular resonance from those emanating more directly from the larynx and trachea, and the larger bronchial divisions.

The vesicular vocal resonance presents in different individuals in health, even greater variations in degree than the vesicular respiration, due to differences in power of voice, gravity of tone, and other circumstances not so obvious. There is not, therefore, in the one case, more than in the other, a certain normal intensity to be referred to as a standard for comparison. In both cases, equally, morbid intensity is not determined by reference to an abstract criterion, or to an average, but by ascertaining, as far as practicable, the degree of resonance natural to the individual; and this is generally done by instituting a comparison of corresponding situations on the two sides of the chest, taking advantage of the laws of disease, in conformity with which, happily, for the most part, either it is confined to one side, or is more advanced on one side than the other. This rule of practice is based on the assumption that in a condition of health, and provided the conformation be symmetrical, the two sides of the chest furnish the same phenomena on auscultation. Theoretically this may be assumed, and as already remarked, it is a fundamental principle in physical exploration. Its importance in diagnosis is made at once apparent by this statement, viz., if the two sides are found to be free from any disparity as respects the normal phenomena obtained by physical exploration, the evidence is conclusive against the existence of intra-thoracic disease. But we have seen that, as regards phenomena incident to respiration, this rule is practically not without frequent and striking exceptions. The same fact will be found to hold good with respect to the phenomena incident to the voice. Hence, it is sufficiently obvious that to avoid the error of mistaking normal differences for the signs of disease, it is highly important to become acquainted with the nature and extent of the deviations from equality which are liable to occur within the limits of health. Fortunately these deviations are found generally to observe certain laws, the knowledge of which will secure against error of diagnosis, which would be unavoidable if such laws did not exist. Proceeding to consider the vesicular vocal resonance in corresponding situations on the two sides of the chest, and in different parts of the same side, it will be convenient to pursue the same course as in treating of the respiratory phenomena under these points of view, taking up successively the more important of the thoracic regions, and giving the results of the analysis of a series of examinations of persons presumed to be entirely free from any disease of the respiratory apparatus. Directing attention first to the summit of the chest, the different regions will be noticed in the same order as under the head of vesicular respiration.

Infra-clavicular region.—Vocal resonance is rarely absent in this region. Of twenty-three examinations it was appreciable in all, but varying widely in degree, being in some instances slight and scarcely appreciable, and in other instances the varied intensity indicated by the terms moderate, considerable, strongly marked, etc. A thrill, more or less in degree, in some instances accompanied the resonance, and was sometimes more marked than the resonance. Pectoriloquy did not exist in any instance. Imperfect whispering pectoriloquy is noted in one instance. A souffle frequently accompanied whispered sounds. The results of a comparison of the two sides of the chest are exhibited in the following table:

Comparison of the Right and Left Infra-clavicular Regions.

Right.	*Left.*
Vocal resonance greater in 20 of 24 examinations.	In none of 24 examinations.
Imperfect whispering pectoriloquy in 1 case.	In no case.
Souffle with whispered words confined to or more marked on this side noted in 4 cases.	In no case.
Greater thrill noted in 2 cases.	In no case.

It thus appears that in a very large proportion of the persons examined relatively to this point, viz., in 20 of 24, the vocal resonance was distinctly greater in the right than in the left infra-clavicular region; there being no obvious disparity in the remaining four cases. These results are opposed to the opinion of Fournet[1], professedly based on numerous observations, viz., that a marked disparity in this region between the two sides is evidence of disease. And as regards the disparity, a law appears to be invariable, viz., the increased resonance is always on the right side. The frequent existence of greater resonance on the right side has been well known to practical auscultators of late years. The fact was first pointed out by Stokes, and was confirmed by the researches of Louis.[1] It is usually attributed to the larger size of the right bronchus.

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[1] Op. cit. page 152, tom. 1.

As regards the amount of disparity noted in the records of the examinations, it differed considerably. In a few instances a resonance was distinct on the right side, none being appreciable on the left. In some instances the difference was slight; in other instances more strongly marked, and occasionally the contrast was striking.

The comparisons were made in every instance with the ordinary stethoscope, and by immediate auscultation; and in about half the examinations Cammann's instrument was used in addition.

Scapular region.—Vocal resonance is generally more or less marked in this region: of twenty-three observations in no instance was there absence of resonance on the two sides. It is habitually less in intensity than at the summit of the chest in front. It is in some instances more marked above, and in other instances below the spinous ridge. Of twelve examinations relative to that point, in precisely the same number of instances, viz., in six, the resonance was greater in the upper as in the lower scapular space. The intensity is almost uniformly greater on the right side. This was true in twenty-two of twenty-three observations. The disparity between the two sides in different persons varies, in some being slight, in others strongly marked. The intensity of the resonance on both sides, also, here as in front differs considerably in different individuals.

A thrill accompanies the resonance in some instances, but less frequently than in the infra-clavicular region. Pectoriloquy, perfect or imperfect, with words spoken aloud or whispered, was not present in any instance; but with whispered words a *souffle* was occasionally observed, oftener on the right side.

Infra-scapular region.—In a large majority of cases the vocal resonance in this part of the chest is greater than over the scapula: it was so noted in fifteen of nineteen examinations, in the remaining four instances the resonance being greater over the scapula. The resonance in some persons is quite as intense in the infra-scapular as in the infra-clavicular region. Here not less than elsewhere, the intensity varies in different individuals. In much the larger proportion of instances, also, there is greater resonance on the right than on the left side. This was observed in seventeen of twenty examinations, no disparity being apparent in the remaining three. A thrill sometimes accompanies the resonance, and occasionally a slight *souffle* when words are whispered.

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[1] Recherches sur la Phthisie, 1843, p. 533.

Mammary and infra-mammary regions.—The resonance in these regions is uniformly less than at the summit of the chest in front: of fourteen examinations it is so noted in all. It is also habitually greater on the right than on the left side. This is noted in fourteen of sixteen examinations, there being no disparity in two instances. A thrill accompanies the resonance in some persons. A *souffle* with whispered words is not noted in any instance. The statement by some writers that the intensity of vocal resonance diminishes regularly from the summit of the chest downward is not applicable to all persons. It is sometimes greater over the lower than over the middle third of the chest, but these instances are exceptions to the general rule. The difference in intensity between the resonance over the upper third, and the two inferior thirds of the same side, is in some instances much more marked on one side than the other, owing not only to the disparity existing between the inferior thirds, but to the fact that a disparity exists at the summit.

Axillary and infra-axillary regions.—In the axillary regions the resonance is usually greater in intensity than over the middle and lower thirds of the chest in front; and in some instances it is quite equal to that of the infra-clavicular region. The intensity is less in the infra-axillary than in the axillary region. In some instances the difference is slight, in others considerable. A thrill attends the resonance in some persons in both regions, but oftener in the axillary. In both the resonance is habitually greater on the right side: of nine comparisons, in eight this disparity was obvious, the resonance seeming to be equal in the single exceptional instance.

In view of the importance, with reference to the diagnosis of disease, of the differences existing more or less frequently between corresponding regions on the two sides of the chest, the following condensed abstract of the foregoing facts pertaining to the respiration and voice is appended:

BRIEF SUMMARY OF FACTS

Relating to disparity between corresponding regions on the two sides of the chest, in healthy individuals, as respects the phenomena incident to respiration and the voice.

1. *Infra-clavicular regions.*—More or less of the characters of

the bronchial respiration generally present on the right side. Greater intensity and more strongly marked vesicular respiration often observed on the left side. Vocal resonance greater on the right side in the larger majority of instances.

2. *Scapular regions.*—Respiration more vesicular and intense in some instances on the left side; and frequently presenting characters of bronchial respiration on the right side. Greater vocal resonance habitually on the right side.

3. *Infra-scapular regions.*—The intensity and vesicular quality sometimes greater on left side; the pitch frequently higher on the right, and rarely on the left side. The vocal resonance generally greater on the right side.

4. *Mammary and infra-mammary regions.*—Greater intensity of the respiratory sound on the left side in a ratio a little less than one-half, and on the right side in a ratio of one-sixth. Vocal resonance habitually greater on the right side.

5. *Axillary and infra-axillary regions.*—Respiratory sound more intense on either side in an equal ratio; the characters of the bronchial respiration presented on the right side in a small proportion of cases. Vocal resonance habitually greater on the right side.

III. PHENOMENA INCIDENT TO THE ACT OF COUGHING.

The phenomena produced by coughing, or tussive phenomena, are comparatively of little importance in auscultation. Nevertheless, they undoubtedly possess a certain value as physical signs of disease, taken in connection with those pertaining to the respiration and the voice. If the stethoscope be placed over the trachea, the act of coughing occasions a forcible shock, and a strong blowing sound. The same results, but less in degree, may be observed at the parts of the chest where the bronchial respiration and voice are sought for in health. These phenomena manifested elsewhere over the chest, constitute morbid signs. Over the chest generally, in health, the sense of impulse or shock is slight, or altogether absent, but a feeble, short, diffused sound is alone heard. The study of the tussive phenomena in different persons, and in different portions of the chest, did not enter into the examinations, the results of the analysis of which have been presented in the foregoing pages.

AUSCULTATION IN DISEASE.

Having studied the phenomena which auscultation of the healthy chest discloses, we are prepared to investigate those incident to disease. In prosecuting the latter investigation, the general objects are as follows: 1. To determine what are morbid sounds and in what particulars they differ from those incident to health. 2. To ascertain the connection between individual morbid sounds and the physical conditions of which, in consequence of this connection, they are the signs: 3. To explain, as far as practicable, the manner in which morbid physical conditions give rise to the phenomena embraced under the head of Auscultation in Disease. Of these three objects I shall consider at length, in the remainder of this chapter, the first and second, devoting to the third relatively but little attention. As already remarked, knowledge of physical signs, their significance and value in diagnosis, is not dependent on our ability always to furnish a complete exposition of the mechanism of their production. Persons may differ in opinion as to the rationale of certain signs, and yet be entirely agreed respecting their special meaning and importance, the latter being based on the uniform relation found by observation to exist between the signs present during life, and the pathological changes ascertained after death. It is certainly very desirable to explain satisfactorily that connection subsisting between physical signs and physical conditions, by virtue of which the former represent the latter; but with our present knowledge, this branch of the subject of physical exploration contains many points not fully settled. In a work intended to be practical, it would be out of place to discuss opinions and theories relating to questions which are as yet open for speculation; and I shall therefore content myself with giving, as concisely as possible, different views, without attempting a full consideration of their respective merits.

In treating of auscultation in disease, as in health, the phenomena incident to respiration, the voice, and the act of coughing, are to be considered under separate heads.

PHENOMENA INCIDENT TO RESPIRATION.

The morbid phenomena incident to respiration admit of a natural division, which it is convenient to observe, into, *First*, the normal respiratory sounds more or less, and variously, modified; *Second*, new or adventitious sounds, having no existence in the healthy chest. Of the phenomena embraced in the first of these two classes, a large proportion are represented by types existing in health; and with these the student who has studied faithfully normal respiratory sounds is already familiar. They are to be found in different parts of the respiratory apparatus when entirely free from disease, and they become signs of abnormal conditions by a change of location. The phenomena embraced in the second class have no counterparts among the sounds incident to normal respiration, and pertain exclusively to the changes produced by disease. We will consider these two divisions separately.

1. MODIFIED RESPIRATORY SOUNDS.—Limiting the attention to the vesicular murmur, exclusive of the tracheal and bronchial respiration, the changes which it undergoes in connection with different forms of disease, on analysis, are resolvable into various kinds of aberration. Its intensity may be increased, or diminished, or it may be suspended. Its quality may be altered, the vesicular character giving place, partially or completely, to tubularity of sound. The pitch may be raised, and perhaps in some instances lowered. The inspiratory and expiratory sounds may be modified separately, or conjointly. The inspiratory sound may be shortened in duration, and the expiratory prolonged. Their rhythmical succession may be disturbed, etc. It is, however, unnecessary to treat of all these varied modifications separately. They do not, as a general remark, occur in connection with disease, singly, but several are usually presented in combination. A judicious classification of the different modifications severally, comprising more or less of the foregoing aberrations, is important to a clear apprehension of the subject. And for all practical purposes the following arrangement suffices.[1]

1. Modifications of the intensity of the vesicular murmur, consisting of *a*, increased intensity; *b*, diminished intensity; *c*, suppressed respiration.

2. Modifications of the quality of the respiratory sounds, associated generally with aberrations in pitch, duration, and rhythm. This division will consist of *a*, bronchial respiration; *b*, broncho-vesicular, commonly called *rude* respiration; *c*. cavernous respiration.

3. Modifications of rhythm, consisting of *a*, shortened inspiration; *b*, prolonged expiration; *c*, interrupted inspiration or expiration.

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[1] This division accords with the arrangement by Barth and Roger. The subdivisions differ from those which they adopt.

I shall consider all the physical signs derived by auscultation which consist of modified respiratory sounds, as embraced under the foregoing divisions and subdivisions; and I shall proceed to describe them under distinct heads in conformity with this arrangement.

1. *Increased Intensity of the Vesicular Murmur—Exaggerated Respiration.*—The respiration is simply increased in intensity, or exaggerated, whenever the loudness of the murmur is augmented, the normal characters, in other respects, remaining unchanged. The sound may be more intense than natural, with, at the same time, alteration in quality, pitch, and rhythm. The modifications will then fall under other divisions. Merely exaggerated respiration preserves the normal characters as regards vesicular quality, pitch, and rhythm.

It has been seen that the intensity of the normal vesicular murmur differs greatly in different persons. How then are we to decide whether a certain loudness be normal or abnormal? If this loudness be found over the whole chest, the presumption is that it is natural to the individual, and it is not to be regarded as a sign of disease. But if, on the other hand, it exist on one side of the chest only, it may be presumed to be a result of disease.

An exaggerated vesicular murmur does not proceed from the portion of lung affected, but from the healthy lung situated either near or remote from the seat of disease. Whenever the lung on one side, or a considerable portion of it, is rendered by disease incompetent to fulfil its part in the respiratory function, the lung on the other side takes on an increased action to supply its place. Hence an increased intensity of the respiratory murmur, corresponding in degree to this augmented activity, the increase of intensity being most marked at the superior and anterior portion of the chest. The exaggerated respiration under these circumstances is vicarious, or supplementary, and has been called by some writers *supplementary respiration.* Laennec applied to it the title of *puerile respiration*, from its resemblance to the naturally loud respiration incident to early life. *Hypervesicular respiration* is another appellation.

Any disease which compromises to much extent the respiratory function of one lung, occasions an increased functional activity of the other. The physical sign of this increased activity, viz., an increased intensity of the vesicular murmur, thus, is indirect evidence of the existence of disease in the opposite side, but it does not afford any information as to the particular form of disease which is present. The pulmonary affections with which it is oftenest associated, and in the most marked degree, are pneumonitis and pleuritis. In the former of these affections, occurring in the adult, at least an entire lobe is rendered, for a time, nearly or quite incompetent to take part in hæmatosis, in consequence of the cells being filled with inflammatory exudation; in the latter affection, the lung on one side is more or less reduced in volume by the compression of effused fluid within the pleural sac. Obstruction to the entrance of air into one lung from the presence of a foreign body, pressure of an enlarged bronchial gland, etc., will also give rise in the other lung to exaggerated respiration. Considerable deposit of tubercle on one side may produce it; and also solidification from extravasated blood, carcinoma, etc. Undue dilatation of the air-cells, or emphysema, limited to one lung, is another affection to be enumerated in the same category.

It is stated by Fournet[1] that exaggerated respiration ensues in healthy lung situated in the immediate vicinity of a local affection which compromises or abolishes the function within a limited space. For example, surrounding a mass of tubercle he thinks the vesicular murmur is rendered unduly intense, and, indeed, he asserts that an abnormally increased vesicular murmur in the surrounding healthy portion of lung is greater in proportion to its proximity to the point of local disease. He cites an instance in illustration of this opinion, and in which advantage of the fact was taken in arriving at an early diagnosis. A patient attacked with all the symptoms of pneumonitis, presented no physical signs of disease save exaggerated respiration on one side of the chest; in a short time the exaggerated respiration was replaced by the physical signs of pneumonitis. The explanation offered by Fournet is, that the inflammation attacked first the central portion of the lung, giving rise, while centrally situated, to exaggerated respiration in the healthy vesicles surrounding the affected portion, and afterward extended to the exterior. Whether the principle laid down by the author just named be correct or otherwise, is not easily determined, nor is it of importance with reference to diagnosis, excepting in such an instance as he has cited; for, assuming that the vesicular murmur does become more intense in the healthy lung surrounding a diseased portion, for example in tuberculous disease, the respiratory sound is at the same time more or less modified by the diseased portion in other respects, presenting the character of a bronchial or broncho-vesicular respiration. In cases of solidification of an entire lobe from pneumonitis, according to Fournet, the vesicular murmur proceeding from the other lobe or lobes of the affected side is exaggerated, and in a more marked degree than that proceeding from the healthy side. Without having taken pains to analyze a series of observations with respect to this point, I should express a different opinion, speaking from the impressions derived from my own experience. I am certain that in some cases, at least, the vesicular murmur over the healthy lobe or lobes of the affected side, is notably less intense than on the opposite side, and even below the normal intensity. This is found to be true in a case of pneumonitis under observation at the very moment that I am penning these remarks.

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[1] Recherches Cliniques, etc.

When the vesicular murmur is abnormally exaggerated, the duration of the inspiratory sound, as a general rule, is somewhat increased. This is because the murmur is heard during the entire act of inspiration, while, if the intensity be not increased, the sound is too feeble to be heard at the beginning of the act when the intensity is the least. The expiratory sound is also much oftener heard, and is comparatively longer in duration. This is due to the fact that the exaggeration affecting equally the sounds of inspiration and expiration, the latter becomes appreciable when, with ordinary normal breathing, it is too feeble to be heard; and for the same reason it acquires a longer duration. In pitch, rhythm, and quality, the expiratory sustains the same relation to the inspiratory sound, as when the two are not exaggerated. This is a fact important to be borne in mind if we would not be led astray by the greater loudness and longer duration of the expiratory sound,—a prominent feature, as will be seen hereafter, of the bronchial respiration. In simple exaggerated respiration the expiratory sound is lower in pitch than the inspiratory, and is continuous with the sound of inspiration, these being the characters belonging to the vesicular murmur when its intensity is not increased. In each of these points it differs from the bronchial respiration. With due attention to these points of difference I cannot conceive that the two need ever be confounded, an error which Barth and Roger state is liable to be committed. An exaggerated vesicular murmur approaches nearer to a cavernous, than to a bronchial respiration; but the coexisting symptoms and signs, in connection with the fact that it is not circumscribed within a limited space, as is the cavernous respiration, suffice for discrimination.

An abnormal intensity of the vesicular murmur is attributable,

as has been stated, to an increased activity of respiration, by way of compensation for suspended function in a portion of the pulmonary organs. This increased activity can only proceed from an expansion of the chest beyond the limits of ordinary normal breathing, and with greater force than is employed in health, in consequence of which a larger quantity of air is drawn into the bronchial tubes, giving rise to a more powerful expansion of the lung; and under these circumstances, a larger number of cells are dilated than in ordinary breathing. Hence the exaggeration of the respiratory sound, the intensity of which depends on the conditions just mentioned. And the fact that in pleuritis, pneumonitis, and tuberculosis, the movements of the affected side are more or less restrained, while those of the opposite side are increased, would lead us to anticipate what (in opposition to the opinion of Fournet), I suspect a series of observations would show to be true, viz., that in these affections the exaggerated respiration is limited to the opposite side of the chest.

As a physical sign of disease exaggerated respiration does not possess great importance. Isolated from other signs it would be insignificant in diagnosis. Taken in connection with other signs it is deserving of attention.

2. *Diminished Intensity of the Vesicular Murmur.—Feeble or Weak Respiration.*—The effect of disease is much oftener to diminish, than to increase the intensity of the vesicular murmur. Feeble or weak respiration is an abnormal modification of very frequent occurrence, and it is a physical sign incident to numerous and varied morbid conditions.

This species of modification, like that just considered, consists of a greater or less diminution in loudness of the respiratory sound, the distinctive characters of the vesicular murmur, pertaining to quality, pitch, and rhythm remaining unaffected. A respiratory sound may be lessened, as well as increased in intensity, with at the same time, alteration in quality, pitch, and rhythm, in which case, the aberration would not fall under the present head, but under those belonging to other divisions of abnormal sounds. In duration, the inspiratory sound is frequently shortened when its intensity is abnormally diminished, the explanation being precisely the converse of that of the longer duration when the murmur is exaggerated. An expiratory sound may or may not be heard. In one form of disease characterized by feeble respiration, it is frequently present and pro-

longed, the diminution of intensity being less marked than in the inspiratory sound. Except in this affection (emphysema), an expiratory sound is rarely heard, and is not prolonged, provided the modification consists in a simple weakness of the murmur, exclusive of any other change.

The various morbid conditions which may induce abnormal feebleness of the vesicular murmur produce this result by four different modes singly or combined, viz., 1. By obstructing the passage of air in some portion of the air-tubes; 2. By obstructing or over-distending the air-vesicles; 3. By removing the lungs from the thoracic walls; 4. By restraining the movements of the chest. Under these several heads I will proceed to mention the more important of the affections in which simple diminution in intensity of the vesicular murmur may be expected to occur, premising that alone, this sign, as well as exaggerated respiration, fails to furnish information respecting the nature of the affection of which it is an effect. To determine the latter point, it must be taken in connection with other signs and with symptoms. In this respect, however, it differs from exaggerated respiration, viz., it often indicates directly the seat of disease, in other words, the diminished intensity of the murmur corresponds in its situation to the locality of the affection upon which it depends.

a. An obstruction in any portion of the air-tubes lessens the loudness of the vesicular murmur by reducing the quantity of air which penetrates the cells. Laryngeal affections, for example, croup, œdema, spasm of the glottis, vegetations which contract the calibre of the canal in this situation, involve this result. The space within the trachea may be reduced, in like manner, by inflammatory deposits, or morbid growths. These causes will diminish the murmur equally on both sides of the chest. An obstruction, however, may be seated in one of the large bronchi, and then the effect upon the respiratory sounds will be limited to the corresponding side. This obtains when a foreign body is lodged in one of the bronchial divisions, which occurs oftener on the right side. A foreign body within the air-passages sometimes changes its place, being at times thrown upward into the trachea, and occasionally transferred, alternately, from one of the bronchi to the other. The abnormal feebleness of the vesicular murmur, under these circumstances, will be variable in degree, at different times, and present itself now on one side, and now on the other side of the chest. This intermittence and alteration afford evidence that the physical sign is due to a movable the most marked degree, are pneumonitis and pleuritis. In the former of these affections, occurring in the adult, at least an entire lobe is rendered, for a time, nearly or quite incompetent to take part in hæmatosis, in consequence of the cells being filled with inflammatory exudation; in the latter affection, the lung on one side is more or less reduced in volume by the compression of effused fluid within the pleural sac. Obstruction to the entrance of air into one lung from the presence of a foreign body, pressure of an enlarged bronchial gland, etc., will also give rise in the other lung to exaggerated respiration. Considerable deposit of tubercle on one side may produce it; and also solidification from extravasated blood, carcinoma, etc. Undue dilatation of the air-cells, or emphysema, limited to one lung, is another affection to be enumerated in the same category.

It is stated by Fournet[1] that exaggerated respiration ensues in healthy lung situated in the immediate vicinity of a local affection which compromises or abolishes the function within a limited space. For example, surrounding a mass of tubercle he thinks the vesicular murmur is rendered unduly intense, and, indeed, he asserts that an abnormally increased vesicular murmur in the surrounding healthy portion of lung is greater in proportion to its proximity to the point of local disease. He cites an instance in illustration of this opinion, and in which advantage of the fact was taken in arriving at an early diagnosis. A patient attacked with all the symptoms of pneumonitis, presented no physical signs of disease save exaggerated respiration on one side of the chest; in a short time the exaggerated respiration was replaced by the physical signs of pneumonitis. The explanation offered by Fournet is, that the inflammation attacked first the central portion of the lung, giving rise, while centrally situated, to exaggerated respiration in the healthy vesicles surrounding the affected portion, and afterward extended to the exterior. Whether the principle laid down by the author just named be correct or otherwise, is not easily determined, nor is it of importance with reference to diagnosis, excepting in such an instance as he has cited; for, assuming that the vesicular murmur does become more intense in the healthy lung surrounding a diseased portion, for example in tuberculous disease, the respiratory sound is at the same time more or less modified by the diseased portion in other respects, presenting the character of a bronchial or broncho-vesicular respiration. In cases of solidification of an entire lobe from pneumonitis, according to Fournet, the vesicular murmur proceeding from the other lobe or lobes of the affected side is exaggerated, and in a more marked degree than that proceeding from the healthy side. Without having taken pains to analyze a series of observations with respect to this point, I should express a different opinion, speaking from the impressions derived from my own experience. I am certain that in some cases, at least, the vesicular murmur over the healthy lobe or lobes of the affected side, is notably less intense than on the opposite side, and even below the normal intensity. This is found to be true in a case of pneumonitis under observation at the very moment that I am penning these remarks.

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[1] Recherches Cliniques, etc.

When the vesicular murmur is abnormally exaggerated, the duration of the inspiratory sound, as a general rule, is somewhat increased. This is because the murmur is heard during the entire act of inspiration, while, if the intensity be not increased, the sound is too feeble to be heard at the beginning of the act when the intensity is the least. The expiratory sound is also much oftener heard, and is comparatively longer in duration. This is due to the fact that the exaggeration affecting equally the sounds of inspiration and expiration, the latter becomes appreciable when, with ordinary normal breathing, it is too feeble to be heard; and for the same reason it acquires a longer duration. In pitch, rhythm, and quality, the expiratory sustains the same relation to the inspiratory sound, as when the two are not exaggerated. This is a fact important to be borne in mind if we would not be led astray by the greater loudness and longer duration of the expiratory sound,—a prominent feature, as will be seen hereafter, of the bronchial respiration. In simple exaggerated respiration the expiratory sound is lower in pitch than the inspiratory, and is continuous with the sound of inspiration, these being the characters belonging to the vesicular murmur when its intensity is not increased. In each of these points it differs from the bronchial respiration. With due attention to these points of difference I cannot conceive that the two need ever be confounded, an error which Barth and Roger state is liable to be committed. An exaggerated vesicular murmur approaches nearer to a cavernous, than to a bronchial respiration; but the coexisting symptoms and signs, in connection with the fact that it is not circumscribed within a limited space, as is the cavernous respiration, suffice for discrimination.

An abnormal intensity of the vesicular murmur is attributable,

as has been stated, to an increased activity of respiration, by way of compensation for suspended function in a portion of the pulmonary organs. This increased activity can only proceed from an expansion of the chest beyond the limits of ordinary normal breathing, and with greater force than is employed in health, in consequence of which a larger quantity of air is drawn into the bronchial tubes, giving rise to a more powerful expansion of the lung; and under these circumstances, a larger number of cells are dilated than in ordinary breathing. Hence the exaggeration of the respiratory sound, the intensity of which depends on the conditions just mentioned. And the fact that in pleuritis, pneumonitis, and tuberculosis, the movements of the affected side are more or less restrained, while those of the opposite side are increased, would lead us to anticipate what (in opposition to the opinion of Fournet), I suspect a series of observations would show to be true, viz., that in these affections the exaggerated respiration is limited to the opposite side of the chest.

As a physical sign of disease exaggerated respiration does not possess great importance. Isolated from other signs it would be insignificant in diagnosis. Taken in connection with other signs it is deserving of attention.

2. *Diminished Intensity of the Vesicular Murmur.—Feeble or Weak Respiration.*—The effect of disease is much oftener to diminish, than to increase the intensity of the vesicular murmur. Feeble or weak respiration is an abnormal modification of very frequent occurrence, and it is a physical sign incident to numerous and varied morbid conditions.

This species of modification, like that just considered, consists of a greater or less diminution in loudness of the respiratory sound, the distinctive characters of the vesicular murmur, pertaining to quality, pitch, and rhythm remaining unaffected. A respiratory sound may be lessened, as well as increased in intensity, with at the same time, alteration in quality, pitch, and rhythm, in which case, the aberration would not fall under the present head, but under those belonging to other divisions of abnormal sounds. In duration, the inspiratory sound is frequently shortened when its intensity is abnormally diminished, the explanation being precisely the converse of that of the longer duration when the murmur is exaggerated. An expiratory sound may or may not be heard. In one form of disease characterized by feeble respiration, it is frequently present and pro-

longed, the diminution of intensity being less marked than in the inspiratory sound. Except in this affection (emphysema), an expiratory sound is rarely heard, and is not prolonged, provided the modification consists in a simple weakness of the murmur, exclusive of any other change.

The various morbid conditions which may induce abnormal feebleness of the vesicular murmur produce this result by four different modes singly or combined, viz., 1. By obstructing the passage of air in some portion of the air-tubes; 2. By obstructing or over-distending the air-vesicles; 3. By removing the lungs from the thoracic walls; 4. By restraining the movements of the chest. Under these several heads I will proceed to mention the more important of the affections in which simple diminution in intensity of the vesicular murmur may be expected to occur, premising that alone, this sign, as well as exaggerated respiration, fails to furnish information respecting the nature of the affection of which it is an effect. To determine the latter point, it must be taken in connection with other signs and with symptoms. In this respect, however, it differs from exaggerated respiration, viz., it often indicates directly the seat of disease, in other words, the diminished intensity of the murmur corresponds in its situation to the locality of the affection upon which it depends.

a. An obstruction in any portion of the air-tubes lessens the loudness of the vesicular murmur by reducing the quantity of air which penetrates the cells. Laryngeal affections, for example, croup, œdema, spasm of the glottis, vegetations which contract the calibre of the canal in this situation, involve this result. The space within the trachea may be reduced, in like manner, by inflammatory deposits, or morbid growths. These causes will diminish the murmur equally on both sides of the chest. An obstruction, however, may be seated in one of the large bronchi, and then the effect upon the respiratory sounds will be limited to the corresponding side. This obtains when a foreign body is lodged in one of the bronchial divisions, which occurs oftener on the right side. A foreign body within the air-passages sometimes changes its place, being at times thrown upward into the trachea, and occasionally transferred, alternately, from one of the bronchi to the other. The abnormal feebleness of the vesicular murmur, under these circumstances, will be variable in degree, at different times, and present itself now on one side, and now on the other side of the chest. This intermittence and alteration afford evidence that the physical sign is due to a movable foreign body, and hence, is a point of importance in the diagnosis. The location of the sign on one side, also, when the presence of a foreign body in the air-passages is ascertained, points to its situation in one of the bronchi, and indicates the particular bronchus (the right or left), in which it is situated. The bronchial tubes, within the pulmonary organs, are liable to be obstructed by the swelling of their lining membrane, incident to inflammation, and from the presence of the inflammatory products, mucus, pus, and coagulable lymph. The respiratory murmur may be diminished, in consequence, on one or both sides. Inasmuch as in bronchitis, generally, the bronchial tubes on both sides are equally affected (this being one of the symmetrical diseases), when the obstruction depends on swelling of the membrane, the effect on the vesicular murmur is usually equal on the two sides. Hence, abnormal feebleness of respiration on the two sides of the chest, is one of the physical signs incident to bronchitis. On the other hand, when the obstruction depends on an accumulation of the products of inflammation, it may be limited to one side, or be greater on one side than on the other, the effect on the respiratory sound, of course, corresponding. Spasm of the bronchial muscle is another morbid condition diminishing temporarily the calibre of the bronchial tubes. Permanent contraction of the tubes, or stricture, may exist as a structural lesion. An enlarged lymphatic gland, or other tumor, may press upon one of the bronchi exterior to the lungs, or on one of their subdivisions, and occasion a feeble vesicular murmur either over the whole, or a part of one side. The clinical discrimination between these various causes is to be made, if practicable, by means of the symptoms and circumstances associated in individual cases. The diagnosis is not always easy, and sometimes impracticable.

b. The cause of an abnormally feeble murmur, when seated in the vesicles, may consist in a morbid deposit blocking them up to a greater or less extent, and excluding the air. Thus in tuberculosis, pneumonia, extravasation of blood, œdema, etc., the physical sign incident to respiration may be simple feebleness of the vesicular murmur. Generally, however, in these affections, either the respiratory sound is suppressed, or, with or without feebleness, it is more or less changed in quality, pitch, and rhythm. Over-distension and enlargement of the vesicles constitute, virtually, an obstruction, the cells remaining filled with air, the renewal with the successive respiratory acts taking place imperfectly, and hence the physical conditions for the production of the vesicular murmur are impaired. An abnormally feeble vesicular murmur, therefore, characterizes the affection called emphysema. In this affection the expiratory sound is frequently prolonged, in consequence of the slowness with which the lungs collapse, and of the obstruction to the passage of air in the bronchial tubes which often coexists, arising from bronchitis and spasm. Prolonged expiration will be considered under a distinct head. I may remark here that, occurring under the circumstances just mentioned, it is to be distinguished from its occurrence under circumstances in which its pathological significance is quite different, by the attendant circumstances, and by its preserving the normal relation, as respects pitch, to the inspiratory sound.

The physical signs derived by percussion in the two forms of obstruction within the vesicles just noticed, viz., from morbid deposit and over-inflation, are directly opposite in character. In the former instance, whether the deposit be tubercle, coagulable lymph, etc., the percussion-sound is more or less dull. In the latter, the resonance is abnormally clear. This alone would suffice for the discrimination between these two kinds of vesicular obstruction.

c. If the lungs are removed at a certain distance from the thoracic walls, the intensity of the murmur is diminished. Under these circumstances, the sound conveys to the mind the idea of distance; it does not seem to be produced in close proximity to the ear, but to come from a source somewhat remote. The appreciation of distance, which undoubtedly belongs to the perception of impressions received through the sense of hearing, in other instances than this, will be found to furnish an attribute to physical signs. The lungs must not be removed beyond a certain limit, else the respiratory murmur will fail to be transmitted. The feeble respiration produced in this way occurs when there exists a small quantity of liquid effusion, of air, or gas, within the pleural sac; and when the pleural surfaces are covered with a thick layer of coagulable lymph. When it is due to the presence of liquid, the effect on the respiratory sound will be manifested at the lower part of the chest, provided the position of the patient be upright, and its situation may be found to vary with the different positions which the patient assumes.[1]

d. The intensity of the vesicular murmur, other things being equal, depends on the extent and force of the respiratory movements. Any morbid condition, therefore, which limits these movements will render the respiratory sound abnormally feeble. For example, in a case of incomplete general paralysis, which recently came under my observation, the respiratory muscles were in a measure involved. The respiratory movements were wanting in strength, and the vesicular murmur was correspondingly feeble on both sides. In cases of hemiplegia, this effect obtains on the paralyzed side. In pleurisy, before effusion has taken place, and in pleurodynia, the pain occasioned by the expansion of the chest on the affected side leads the patient instinctively to restrain the movements on that side. Hence, abnormal feebleness of the vesicular murmur belongs equally to both these affections, irrespective of the additional cause already mentioned, incident to the first at a later period. The movements of the chest on one side may be restrained mechanically, in consequence of permanent contraction as the sequel of chronic pleurisy, of morbid pleuritic adhesions, of injury to the thoracic walls, and deformity.

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[1] That a thin stratum of liquid may be equally diffused over the lung, as contended by Woillez, may fairly be doubted.

Whenever by any of the modes just named the vesicular murmur is rendered abnormally feebler on one side of the chest, the respiratory sound on the other side is likely to become exaggerated, and the contrast between the two sides is thereby enhanced.

It is needless to state that in order to judge of abnormal feebleness of the vesicular murmur, as of most of the physical signs, there is no ideal standard to which reference is to be made, but it is determined by comparison of corresponding regions of two sides of the chest. In drawing inferences from the results of this comparison, it is sometimes highly important to bear in mind the fact, that in a certain proportion of individuals in good health and with chests well formed, a natural disparity exists as regards the intensity of the vesicular murmur. This fact has appeared in the portion of this chapter devoted to the results of auscultation in health. A natural disparity may mislead the auscultator, the greater relative feebleness on the one hand, or on the other hand, a normal exaggeration, being attributed incorrectly to disease existing on one or the other side. This liability to error is not to be lost sight of, especially in the diagnosis of tuberculous disease, a disease in which in certain cases few and slight deviations from equality of the two sides at the summit of the chest, are justly regarded as highly significant. The results of examinations of the healthy chest not only enforce the caution just given, but lead to another very important consideration. In much the larger proportion of instances of relative feebleness of the vesicular murmur on one side compatible with health, it is observed on the right side. It follows from this fact that comparative feebleness on the right side is much less likely to be the result of disease than when it is found to exist on the left side. A relatively feeble murmur on the left side in the great majority of instances denotes disease ; but existing on the right side, in a considerable proportion of cases it is due to a natural disparity.

Diminished intensity of the vesicular murmur, when it is evidently attributable to a morbid condition, as already remarked, alone, gives little or no information respecting the particular condition upon which it depends. Isolated from other signs, therefore, and from symptoms, its diagnostic value would be small, but associated with the information derived from other sources it becomes a valuable sign.

3. *Suppressed respiration.*—The respiration is said to be suppressed when no sound whatever is appreciable by auscultation : the respiratory acts take place without giving rise to any audible phenomena. This effect may be produced by each of the four modes which have been seen to occasion abnormal feebleness of the respiratory murmur : their operation being pushed to a certain extent, the sound is abolished. Suppression is therefore liable to occur in connection with any of the various morbid conditions which induce feebleness of respiration. This being the case, it is only necessary under this head to repeat an enumeration of the affections which were mentioned in connection with the modification last considered.

Obstruction of the larynx from inflammatory exudation, œdematous infiltration, vegetations, spasm, or the presence of a foreign body, may extinguish all sound over the entire chest. A foreign substance lodged in one of the bronchi may produce this effect on the corresponding side, giving rise to exaggerated respiration on the other side. Absence of all sound obtains in some cases of bronchitis, from the swelling of the membrane. Its temporary absence over a portion of the chest, owing to an accumulation of mucus in some of the bronchial tubes, is occasionally observed in that affection ; and under these circumstances it is sometimes abruptly restored in consequence of the removal of the obstruction by an act of coughing. Pressure of an enlarged bronchial gland, or other tumor, on a bronchial tube, may be sufficient to produce complete absence of sound.

In some cases of pneumonitis, tuberculosis, pulmonary apoplexy, œdema, etc., the respiration is suppressed. The vesicular murmur is generally abolished in connection with these affections over the solidified portion of the lung, but, as will be seen presently, the murmur frequently is replaced by a respiratory sound modified in quality, etc., viz., the bronchial respiration. In some cases of emphysema no respi-

as has been stated, to an increased activity of respiration, by way of compensation for suspended function in a portion of the pulmonary organs. This increased activity can only proceed from an expansion of the chest beyond the limits of ordinary normal breathing, and with greater force than is employed in health, in consequence of which a larger quantity of air is drawn into the bronchial tubes, giving rise to a more powerful expansion of the lung; and under these circumstances, a larger number of cells are dilated than in ordinary breathing. Hence the exaggeration of the respiratory sound, the intensity of which depends on the conditions just mentioned. And the fact that in pleuritis, pneumonitis, and tuberculosis, the movements of the affected side are more or less restrained, while those of the opposite side are increased, would lead us to anticipate what (in opposition to the opinion of Fournet), I suspect a series of observations would show to be true, viz., that in these affections the exaggerated respiration is limited to the opposite side of the chest.

As a physical sign of disease exaggerated respiration does not possess great importance. Isolated from other signs it would be insignificant in diagnosis. Taken in connection with other signs it is deserving of attention.

2. *Diminished Intensity of the Vesicular Murmur.—Feeble or Weak Respiration.*—The effect of disease is much oftener to diminish, than to increase the intensity of the vesicular murmur. Feeble or weak respiration is an abnormal modification of very frequent occurrence, and it is a physical sign incident to numerous and varied morbid conditions.

This species of modification, like that just considered, consists of a greater or less diminution in loudness of the respiratory sound, the distinctive characters of the vesicular murmur, pertaining to quality, pitch, and rhythm remaining unaffected. A respiratory sound may be lessened, as well as increased in intensity, with at the same time, alteration in quality, pitch, and rhythm, in which case, the aberration would not fall under the present head, but under those belonging to other divisions of abnormal sounds. In duration, the inspiratory sound is frequently shortened when its intensity is abnormally diminished, the explanation being precisely the converse of that of the longer duration when the murmur is exaggerated. An expiratory sound may or may not be heard. In one form of disease characterized by feeble respiration, it is frequently present and pro-

4. *Bronchial respiration.*—Under the head of bronchial respiration, I embrace all sounds which, in addition to this title, are called *blowing* and *tubular*, exclusive of cavernous respiration, to which the former of the two terms last mentioned will equally apply. Laennec described a *blowing* respiration distinct from the bronchial and cavernous. In this he is followed by Walshe and others. For all practical purposes it suffices, and, indeed, as it seems to me, with sufficient intrinsic propriety, to consider both as essentially the same species of modification, presenting in several particulars, as will be presently seen, variations in different cases. This view of the subject is sanctioned by high authority.[1]

The appellation bronchial respiration imports that the sound corresponds to that heard over the sites of the bronchi in the healthy chest. The term, however, has a more comprehensive signification. It includes sounds analogous to those produced within the larynx and trachea. A morbid bronchial respiration may be defined to be a respiratory sound resembling or identical with the normal bronchial or the laryngo-tracheal respiration, supplanting the vesicular murmur in a part of the chest to which this murmur belongs in a healthy condition—in other words, elsewhere than at the upper portion of the sternum, and on either side, near the sterno-clavicular junction, and at the upper portion of the interscapular space, these being the situations where the normal bronchial respiration is to be sought for. With this definition, the student familiar with the characters which distinguish the tracheal and bronchial sounds from the vesicular murmur, which have been considered fully under the head of Auscultation in Health, will have no difficulty in understanding and in practically recognizing the bronchial respiration incident to disease. In describing the essential traits pertaining to morbid bronchial respiration, it is only necessary to reproduce the description already given of the tracheal and bronchial sounds contrasted with the vesicular murmur. The distinctive characters are as follows: An inspiratory sound, tubular or blowing, in place of the peculiar character to which reference in the foregoing pages has frequently been made under the name of the vesicular quality; shorter in duration, commencing with the beginning of the inspiratory act, and ending before the act is completed; the pitch of the sound higher. An expiratory sound, prolonged, frequently nearly or quite as long, and sometimes even longer than the inspiratory, succeeding the inspiratory sound after an interval, owing to the fact just stated, that the inspiratory sound ends before the completion of the respiratory act; the pitch of sound higher than that of the inspiratory, and the intensity generally greater. The student is again requested to impress on the memory these several points of distinction, with reference to the discrimination of bronchial respiration, not only from the vesicular murmur, but from another modification included in this class, called the cavernous respiration. At the risk of incurring the charge of a needless repetition, in order that the points distinguishing the bronchial, may be again contrasted with the characters belonging to the vesicular respiration, the latter are reproduced in this connection. They are as follows: An inspiratory sound characterized by the vesicular quality; lower in pitch than the tracheal or bronchial inspiration. An expiratory sound, when present, much shorter in duration, less intense and lower in pitch than the sound of inspiration.

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[1] Barth and Roger.

Contrasted with the vesicular respiration, the bronchial is said to be characterized by greater *hardness* and *dryness*. These terms, although in vogue since the time of Laennec, do not seem to me to express properties of sound, of which, in this comparison, the mind receives a very distinct idea. The distinctions pertaining to intensity, rhythm, quality, and pitch, are much more definite, and are sufficient of themselves for the discrimination. I shall therefore dispense with the use of the former terms after this allusion to them. They appear to me to be rendered superfluous, especially by attention to variations in pitch, an aspect under which respiratory sounds have hitherto been but little studied.

The intensity of the bronchial respiration varies greatly, not only in different affections to which it is incident, but in different cases of the same disease. It is not to be distinguished practically by its intensity so much as by the other characters which belong to it, and the latter may be present, and sufficiently marked, when the sound is feeble, as well as when it is loud. The intensity, however, in certain affections, pneumonitis especially, is often great, being equal to and at times exceeding that of the normal tracheal respiration. In some instances of intense bronchial respiration, the sound, in addition to a strongly marked tubular quality, has a peculiar ringing, like that produced by blowing through a tube of metal, and hence called a metallic intonation. It is oftener marked in the expiratory than in the inspiratory sound. The normal tracheal respiration occasionally presents this character in forced breathing. This is an incidental feature of the bronchial respiration occurring in certain cases of pneumonitis, and not possessing special diagnostic significance.

In others of the ordinary characters than intensity, the bronchial respiration varies. The pitch is not the same in all cases, but this difference obtains in different persons as respects the tracheal and the normal bronchial sounds. Both the inspiratory and expiratory sounds vary in duration, as well as in their relative intensity. Either may be present without the other. In some instances the sound appears to be produced in close proximity to the ear; and sometimes, indeed, the air appears to enter and again emerge from the meatus. This was the ground of Laennec's division into bronchial and blowing respiration, the latter term being applied when the auscultator experiences a sensation as if the breath of the patient actually traversed the stethoscope. It suffices, however, to consider this as simply an incidental feature of the bronchial and possibly of the cavernous respiration. In some instances in which this is strongly marked, the illusion is almost complete, and, quoting the language of Laennec, "it is only from the absence of the feeling of titillation and of warmth or coldness which a blast of air so impelled must necessarily occasion, that we are held to doubt its reality."

In other cases the sound gives the impression of emanating from a source more or less distant from the walls of the chest. It is important to be borne in mind that not only is the bronchial respiration incident to different cases of disease, thus variously modified, but that all the characters which serve to distinguish it from the vesicular respiration are by no means uniformly present. The existence of an inspiratory without an expiratory sound, and *vice versa*, divests it of several of the distinctive traits which are associated when a sound coexists with both acts of respiration. In such instances we are to determine that the respiratory sound is bronchial by the characters which remain. The bronchial respiration, like the tracheal, differs in intensity, and in other respects, with different successive respirations, always, however, preserving certain characteristics. Skoda contends that it is an intermittent sign, frequently ceasing for a series of inspirations, and then reappearing. This does not, however, accord with the experience of others, the latter, so far as my observations go, being correct as the general rule. Its occasional cessation and reappearance after coughing and expectoration, is a fact which I have distinctly observed.

With what physical condition of the lungs is the bronchial respiration associated? This question may be explicitly answered. It is incident to abnormal density of the pulmonary structure. Whenever the bronchial respiration is present it denotes increased density of lung.[1] The converse of this, however, is not true, viz., that whenever the density of lung is increased it gives rise to bronchial respiration. The sign always denotes the morbid physical condition just stated, but as will be seen presently, the physical condition may exist without giving rise to the sign. Increased density of lung is incident to diseases which induce condensation by pressure. This effect follows the accumulation of liquid within the pleural sac, within the pericardium, and the development of tumors encroaching on the thoracic space. Much oftener, however, it proceeds from a morbid deposit within the pulmonary structure. Bronchial respiration, therefore, may be a sign, on the one hand, of pleurisy, or hydrothorax, or hydro-pericardium, of aneurismal and other tumors; and, on the other hand, of pneumonitis, tuberculosis, œdema, carcinoma, and pulmonary apoplexy. Of the several affections last-mentioned, it is more constantly present in the two first, viz., pneumonitis and tuberculosis. On this account, and owing to the frequency of these affections, the sign is especially important with reference to their diagnosis. Before directing further attention to it in connection with these affections respectively, we will inquire how does the increased density of lung incident to different forms of disease give rise to a bronchial respiration? To this inquiry I shall devote brief consideration.

The explanation of bronchial respiration offered by Laennec, and up to the present time generally accepted, is that the sound is in fact the normal bronchial respiration, which, owing to conditions of disease is transmitted to the ear, disconnected from the vesicular respiration. The bronchial respiration appears in connection with physical conditions which involve suppression of the vesicular murmur. In health, the latter, as it were, stifles any sounds emanating or propagated from the bronchial tubes. Moreover, the lung, when its density is increased, has been supposed to become a much better conductor of sound than air-vesicles filled with air. These two circumstances, viz., abolition of the vesicular murmur, and the transformation of the pulmonary substance into a better conductor of sound, in the opinion of Laennec, are sufficient to account for the bronchial respiration, the source of the sound, according to him, being the large and small bronchial tubes. The sufficiency of this explanation has been called in question, in consequence of the bronchial respiration incident to disease being sometimes more intense than even the tracheal sounds; and, differing from the tracheal and normal bronchial respirations, in some cases, in quality and pitch. The fact that solidification of lung, when the bronchial tubes are free from obstruction, is not invariably associated with the bronchial respiration, but in some instances gives rise to suppression of all sound, is thought to militate against the hypothesis of Laennec. Again, when the lung is solidified, as in cases of pneumonitis, it is doubted by some whether, owing to its inability to collapse and expand with the two respiratory acts, a current of air circulates in the pulmonary bronchial tubes with sufficient force to give rise to sound. Finally, according to Skoda, increased density of the lung does not render it a better conductor of sound. The latter statement is based on comparative experiments, made with the pulmonary organs removed from the body in a healthy condition, and when solidified by disease. Other observers, however, from similar experiments, do not arrive at the same conclusion.

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[1] As an apparent exception to this statement, dilatation of the bronchiæ might be cited. Dilatation is, however, as will be seen hereafter, always associated with increased density of lung.

Walshe states, as the results of experiments made by himself, that sound may be conducted with great intensity by solidified lung, but not invariably; and that as regards the conducting power, when the physical conditions to all appearances are the same, differences are found to exist which it is not easy to explain. That a current of air is not received into the pulmonary bronchial tubes by the act of inspiration, and expelled by expiration with sufficient force to generate a tubular sound, is assumed rather than established. The movements of the chest on the affected side, in cases of pneumonitis, with solidification of one or more lobes, are not much, if at all, diminished either in power or extent; and it seems altogether probable that, notwithstanding the comparative incompressibility of the lung, the bronchial tubes remaining unobstructed undergo alternate contraction and dilatation.[1] The opinion of Andral, that the obstruction to the entrance of air into the air-cells by arresting suddenly the current, and increasing the pressure of the air upon the bronchial tubes, tends to develope an exaggerated sound therein, although repudiated by high authority, is not disproved, and seems rational.[1] With regard to the greater intensity of the bronchial than the tracheal respiration, in some cases, and variations in pitch, it is certain that differences as respects these characters, do exist in a certain proportion of cases. A morbid bronchial respiration is sometimes not only more intense than the sound emanating from the trachea of the same person and at the same time, but notably higher in pitch. It may also present a metallic quality, when the tracheal sound of the same person at the same time is devoid of this quality. Nevertheless, as respects the distinctive characters which the tracheal and normal bronchial respiration present in contrast with the vesicular murmur, they belong equally to the bronchial respiration incident to disease. The latter, when strongly marked, as, for example, frequently in cases of pneumonitis, is identical with the sounds heard over the trachea as regards tubularity, duration of the inspiratory and expiratory sounds, the rhythmical succession of the latter, and their relative intensity and pitch, these constituting, as has been seen, the traits by which these sounds are distinguished from the vesicular murmur. This being the case, in the production of the bronchial respiration incident to disease, the tracheal and normal bronchial respiration, it is reasonable to infer, must either be reproduced within the bronchial tubes, or conveyed to the ear by conduction. Circumstances incidental to their manifestation in disease produce in certain cases the variations in quality, pitch, and intensity to which reference has been made. According to Skoda, the sounds may be reproduced. He attributes the origin of morbid bronchial respiration in certain cases, to the principle of consonance. The air contained in the pulmonary bronchial tubes, according to this view, undergoes vibration consonating with those caused by respiration within the trachea and large bronchi, in the same way that musical notes are repeated upon the strings of a violin or piano-forte when the corresponding strings of another instrument in its vicinity are struck. This fanciful hypothesis, which appears to be readily received by many, I shall notice somewhat more fully in connection with the explanation of vocal signs. The simple fact that the loudness of the bronchial respiration of disease is often equal to and sometimes exceeds the intensity of the tracheal sounds, suffices to disprove it, for a sound reproduced by consonance is always much less intense than that which originates it. The variation in pitch which is sometimes observed is also fatal to the hypothesis, for a consonating sound is always in unison with the primitive sound. Without denying that sonorous vibrations within the pulmonary bronchial tubes may consonate with those which take place in the trachea and larger bronchial tubes the disparity in pitch and intensity disproves the validity of the explanation under circumstances in which, according to Skoda, the principle of consonance is particularly applicable, viz., when the bronchial respiration incidental to disease is intensely developed.

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Regarding, then, the bronchial respiration as consisting of transmitted sounds, they are produced within the trachea, the bronchi, and probably also within the subdivisions of the latter, and are conducted by solidified lung to the ear of the auscultator. In what proportion they are due, respectively, to the trachea, and the large bronchi exterior to the lungs, and to what extent sounds generated within the pulmonary bronchial subdivisions may be combined, are points not easily determined. It is not difficult to conceive that the sounds emanating from the trachea may be conveyed with considerable intensity to different parts of the chest, after applying the stethoscope on the back of the neck, and listening to these sounds in that situation transmitted through the vertebræ and mass of muscle which intervene between the ear and the trachea. The conduction, however, of the sounds generated within the trachea, and the bronchi, as in the conditions of health, will not suffice to explain the intensification of sound which sometimes characterizes the bronchial respiration in disease, nor the disparity in pitch which is observed. These differences must be owing to some agencies pertaining to the bronchial tubes within the lungs, or to the pulmonary structure. Sonorous vibrations propagated to the pulmonary bronchial tubes rendered firm and unyielding by surrounding solidification, according to Fournet, Barth and Roger, and others, are reinforced and strengthened by reverberation, and thus acquire an increased intensity. Other physical influences are doubtless involved, which are not, as yet, satisfactorily explained. The fact that frequently, in the affections to which bronchial respiration is incident, the respiratory movements are made with an abnormal quickness and force, will account for the bronchial respiration being more intense than the tracheal with ordinary breathing in a healthy person, but not, of course, for an intensity greater than the tracheal sounds of the patient at the time of the examination. It has been seen in connection with the subject of auscultation in health, that the intensity of the tracheal sounds is greatly increased

With what physical condition of the lungs is the bronchial respiration associated? This question may be explicitly answered. It is incident to abnormal density of the pulmonary structure. Whenever the bronchial respiration is present it denotes increased density of lung.[1] The converse of this, however, is not true, viz., that whenever the density of lung is increased it gives rise to bronchial respiration. The sign always denotes the morbid physical condition just stated, but as will be seen presently, the physical condition may exist without giving rise to the sign. Increased density of lung is incident to diseases which induce condensation by pressure. This effect follows the accumulation of liquid within the pleural sac, within the pericardium, and the development of tumors encroaching on the thoracic space. Much oftener, however, it proceeds from a morbid deposit within the pulmonary structure. Bronchial respiration, therefore, may be a sign, on the one hand, of pleurisy, or hydrothorax, or hydro-pericardium, of aneurismal and other tumors; and, on the other hand, of pneumonitis, tuberculosis, œdema, carcinoma, and pulmonary apoplexy. Of the several affections last-mentioned, it is more constantly present in the two first, viz., pneumonitis and tuberculosis. On this account, and owing to the frequency of these affections, the sign is especially important with reference to their diagnosis. Before directing further attention to it in connection with these affections respectively, we will inquire how does the increased density of lung incident to different forms of disease give rise to a bronchial respiration? To this inquiry I shall devote brief consideration.

The explanation of bronchial respiration offered by Laennec, and up to the present time generally accepted, is that the sound is in fact the normal bronchial respiration, which, owing to conditions of disease is transmitted to the ear, disconnected from the vesicular respiration. The bronchial respiration appears in connection with physical conditions which involve suppression of the vesicular murmur. In health, the latter, as it were, stifles any sounds emanating or propagated from the bronchial tubes. Moreover, the lung, when its density is increased, has been supposed to become a much better conductor of sound than air-vesicles filled with air. These two circumstances, viz., abolition of the vesicular murmur, and the transformation of the pulmonary substance into a better conductor of sound, in the opinion of Laennec, are sufficient to account for the bronchial respiration, the source of the sound, according to him, being the large and small bronchial tubes. The sufficiency of this explanation has been called in question, in consequence of the bronchial respiration incident to disease being sometimes more intense than even the tracheal sounds; and, differing from the tracheal and normal bronchial respirations, in some cases, in quality and pitch. The fact that solidification of lung, when the bronchial tubes are free from obstruction, is not invariably associated with the bronchial respiration, but in some instances gives rise to suppression of all sound, is thought to militate against the hypothesis of Laennec. Again, when the lung is solidified, as in cases of pneumonitis, it is doubted by some whether, owing to its inability to collapse and expand with the two respiratory acts, a current of air circulates in the pulmonary bronchial tubes with sufficient force to give rise to sound. Finally, according to Skoda, increased density of the lung does not render it a better conductor of sound. The latter statement is based on comparative experiments, made with the pulmonary organs removed from the body in a healthy condition, and when solidified by disease. Other observers, however, from similar experiments, do not arrive at the same conclusion.

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Some of the circumstances accounting for differences in different cases, as regards the intensity of the bronchial respiration are obvious. Other things being equal, the greater the degree of density, the more complete is the conduction of sound. If the solidification be continuous from the larger bronchial tubes to the exterior of the lung, the intensity will be greater than if the continuity be interrupted by healthy structure, not only because air-vesicles containing air conduct sound more imperfectly, but also from the fact that the strength of sonorous vibrations is impaired by passing from one medium to another. With the same amount of solidification, the greater the proximity to the larger tubes, the louder will be the sound; hence, the bronchial respiration is more strongly marked when the physical conditions favorable to its production are situated near the roots of the lungs, in proximity to the trachea and large bronchi, and surrounding the immediate subdivisions of the latter. In so far as the sign may be dependent on the passage to and fro of air within the bronchial tubes distributed through the lung, it will of course be affected by obstruction of these tubes from the accumulation of mucus or other morbid products. In addition to these circumstances, there are others which are not fully understood, and which, in some instances, occasion suppression of all respiratory sound when the conditions favorable for the bronchial respiration appear to be present. The completeness and intensity, on the other hand, with which this sign will be presented, will depend on the concurrence of all the circumstances involved in its development and transmission.

The affection in which the bronchial respiration is most constantly present, as well as oftenest intense, and in the union of its general distinctive characters most complete, is pneumonitis. As this affection in the adult generally is seated in the inferior lobe, and extends over the entire lobe, a well-marked bronchial respiration conjoined to dulness on percussion over the lower scapular and infra-scapular regions, in conjunction with the symptoms of intra-thoracic inflammation, is conclusive evidence of the presence of that disease, advanced to the second stage, or the stage of solidification. The transition, on the surface of the chest, from the vesicular respiration to the bronchial is abrupt, and it is generally easy to determine, with the stethoscope, the line of demarcation between the two. This line, marked on the chest, will be found to pursue the direction of the interlobar fissure. If this line has been previously determined by percussion, auscultation, in the way just mentioned, will afford confirmation of its correctness. A sufficiently large collection of cases of pneumonitis will present every shade of intensity of the bronchial respiration, and the different variations in other characters. In some cases an inspiratory sound will alone be heard, and in others the expiratory; in pitch the sound may be more or less acute, and it may or may not possess a metallic intonation. In a small proportion of cases it is absent, and there is suppressed respiration: while, therefore, the bronchial respiration, in connection with the circumstances above mentioned, is positive proof of the existence of the second stage of pneumonitis, the abolition of all respiratory sound, in connection with the same circumstances, is not proof that pneumonitis does not exist. In the form of pneumonitis peculiar to children, lobular pneumonitis, in which the inflammation invades irregularly distributed and isolated lobules of both lungs, the bronchial respiration is less marked, and for other reasons, more appropriately considered hereafter, this sign is much less available in diagnosis.

Next to pneumonitis in the frequency with which the bronchial respiration is associated, is tuberculosis. A mass of tubercle, situated at the summit of the chest, in proximity to some of the large subdivisions of the bronchi, may give rise to a well-marked, and sometimes an intense bronchial respiration, rarely, however, so intense as may attend the consolidation from pneumonitis. Existing at the summit of the chest on one side, over a space not extensive, conjoined with dulness on percussion, and certain symptoms, such as loss of weight, pallor, accelerated pulse, and especially hæmoptysis, the diagnosis hardly admits of doubt. Often, however, in connection with a tuberculous deposit, the respiratory sound, although distinctly modified, is not sufficiently so to constitute a well-marked bronchial respiration, and the modification will fall under the head to be next considered.

In œdema of the lungs the bronchial respiration is occasionally present, but not often strongly marked, never presenting the intensity and metallic quality observed in some cases of pneumonitis. The when the respiration is voluntarily forced. It is therefore to be borne in mind, that the intensity of the tracheal respiration with ordinary breathing in health is not a criterion by which to judge whether the bronchial respiration incident to disease is intensified by some cause or causes within the pulmonary organs, but the proper standards of comparison are the tracheal sounds of the patient which are incident to the same circumstances under which the morbid bronchial respiration is observed.

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In œdema of the lungs the bronchial respiration is occasionally present, but not often strongly marked, never presenting the intensity and metallic quality observed in some cases of pneumonitis. The same is true of pulmonary apoplexy and carcinoma of the lungs. These forms of disease, more especially the two last, are extremely rare, and their diagnosis involves, on the one hand, the presence, and, on the other hand, the absence of signs and symptoms, to which reference will be made hereafter.

In pleurisy affecting the adult, a well-marked bronchial respiration is observed in a certain proportion of cases. Of twenty-six cases, selected indiscriminately, in the wards of the hospitals *Hôtel Dieu* and *La Charité*, at Paris, Barth and Roger state that it existed in nine, and was absent in seventeen. It is incident to this affection much more frequently in children, its co-existence in them being the rule according to Dr. Swett.[1] Occurring in pleurisy, it is due to condensation of the lung from compression by the liquid effusion within the pleural sac, and is usually limited to the summit of the chest, the pressure of the fluid pushing the lung upward, except in some instances in which it is prevented from yielding to the force of the pressure, in this direction, by morbid attachment of the pleural surfaces. In some cases, however, it is more or less diffused over the chest. Such cases are met with much oftener among children than adults. When heard below the level of the fluid it is rarely intense, and the sound seems to come from a distance. In the great majority of cases, certainly among adults, suppression of respiration over the chest, below the level of the liquid effusion, characterizes cases of pleurisy. This, in fact, is the rule, the instances in which a diffused distant bronchial respiration is appreciable, being exceptions.

The physical conditions in hydrothorax are the same as in pleurisy, so far as concerns their effect on respiratory sounds; but inasmuch as, in this affection, liquid effusion takes place in both sides of the chest, the quantity necessary to produce a degree of compression sufficient for the development of a well-marked bronchial respiration, is hardly compatible with life.

As already stated, compression of the pulmonary parenchyma by other causes than pleuritic effusion may give rise to the bronchial respiration. Barth and Roger state that in two instances it was observed by them in connection with an accumulation of fluid within the pericardial sac, the non-existence of liquid in the pleural cavity, and of pneumonitis, or solidification from other disease, being determined by autopsical examinations. It is evident that a tumor developed within or extending into the chest may produce the same effect.

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[1] Diseases of the Chest, etc.

Abnormal dilatation of the bronchial tubes is to be added to the foregoing list of affections giving rise to the bronchial respiration. It is difficult to determine how much influence is to be attributed to the dilatation, since it is generally associated with more or less induration of the pulmonary tissue surrounding the dilated tubes.

From the relations which have thus been seen to subsist between bronchial respiration and different pulmonary affections, pneumonitis and tubercle more especially, it is sufficiently apparent that it is a highly important physical sign, holding very frequently a prominent place among the phenomena involved in diagnosis. Practical acquaintance with its distinctive characters is therefore indispensable to the skilful exercise of the art of physical exploration; and this may be readily acquired, since, as has been already stated more than once, these characters may be studied as well by means of auscultation in health, as in disease.

5. *Broncho-vesicular, or rude respiration.*—The abnormal modification commonly called *rude* respiration, I have ventured to designate by a new title, viz., *broncho-vesicular*, an appellation expressing both the character and source of the sounds, while the term *rude*, in this application, is not only indefinite, but even its correctness admits of question. A bronchial respiration we have seen to be characterized, first and specially, by the absence of the vesicular quality, which is replaced by a tubular or blowing sound; now, in certain forms of disease, the respiratory sound presents the tubular or blowing and the vesicular qualities, combined in varied proportions; and, at the same time, other of the characters of the bronchial respiration may be more or less associated. This modification I propose to distinguish as the broncho-vesicular respiration.

If the reader will take the trouble to consult different works on the subject of physical exploration, he will find a singular want of clearness in the manner in which this sign is usually defined; and it is exceedingly difficult for the student to form a correct idea of what is intended to be indicated by the term rude respiration. All concur in saying that the rude respiration merges insensibly into the bronchial respiration. It is, in fact, neither more or less than an imperfectly developed bronchial respiration, which in the process of certain diseases, as will be seen presently, it may both precede and follow. Decomposed by analysis it consists of the same elementary characters as the bronchial respiration, the chief points of difference being that the vesicular quality, although impaired, is not lost.

In describing the distinctive characters of the broncho-vesicular respiration, as contrasted with a healthy vesicular murmur, the inspiratory and expiratory sounds are to be considered separately. In determining these characters clinically, in cases of disease, of course comparison is made of corresponding regions on the two sides of the chest; a healthy vesicular murmur, or an approximation thereto, being presumed to exist on one side. This comparison is necessary in judging of this modification more than in determining the presence of a bronchial respiration, for the characters in the latter are more distinct. As remarked under the head of Auscultation in Health, in quality, as well as in intensity of the normal respiratory sounds, marked differences exist in different individuals. The natural respiration in some persons, compared with that in others, might be called in some particulars broncho-vesicular.

The intensity of the inspiratory sound in the broncho-vesicular respiration may be greater or less than in the vesicular. The intensity does not furnish a distinctive feature. It is frequently shorter in duration than the vesicular, the sound ending before the close of the inspiratory act; in other words being unfinished. It has less of the vesicular quality, and more of the bronchial or tubular, as the title imports. It is higher in pitch. The latter is a feature highly distinctive, easily appreciated, and which is therefore of considerable importance. It is a feature to which attention had not been called, prior to the publication by the author to which reference has already been made.[1] I am persuaded, however, that practical auscultators have been accustomed to recognize, unconsciously, what they have called a rude respiration, in a great measure by its difference in pitch. I say unconsciously, for it is evident that sounds may be discriminated practically, without a full knowledge of the special characters by which they are distinguished, this being obtained by careful and accurate analysis. In comparing sounds on the two sides of the chest which differ but slightly, it is easier to appreciate a variation in pitch than a difference in the amount of vesicular quality, although, probably, each involves the existence of the other.

The expiratory sound may be present or absent. It is much oftener present than in healthy vesicular murmur. It may be present without any sound of inspiration. It is oftener prolonged, being nearly or quite as long as the sound of inspiration, when both are present, and sometimes longer. From the fact that the inspiratory sound is unfinished, an interval separates the two sounds, as in the bronchial respiration. In these several points the reader will not fail to notice the identity with the bronchial respiration. This holds good still farther. The expiratory sound is higher in pitch, and frequently more intense than the inspiratory. It was observed by Jackson (who first called attention to the importance of the expiratory sound in physical diagnosis), and the fact has been confirmed by Fournet and others, that in the development of the rude respiration the morbid alteration generally first appears in the expiration. It becomes more intense and prolonged. The change in pitch, becoming higher than that of the inspiratory sound, reversing in this respect the condition of health, appears to have escaped observation. This change is of considerable importance to be borne in mind; for, under other circumstances, when the expiration is prolonged, indicating physical conditions differing from those which give rise to the broncho-vesicular respiration, the pitch of the expiratory sound does not become higher than that of the inspiratory.

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[1] On Variations of Pitch, etc., Prize Essay. Transactions of Am. Medical Association, 1852.

To recapitulate the characters of the broncho-vesicular respiration: *Inspiration* presenting vesicular and tubular qualities mixed; shortened in duration; pitch raised; intensity variable; sometimes alone present. *Expiration*, oftener present; frequently existing alone; prolonged; occurring after an interval; pitch higher than that of inspiration and oftener more intense.

Keeping in view these distinctive characters, it is not difficult to determine clinically the existence or non-existence of the modification under consideration. It should be discriminated readily from exaggerated or puerile respiration, after a little experience in physical exploration;[1] for, in the latter modification, there is no change in quality or pitch of the inspiration, but simply increased intensity; the expiratory is continuous with the inspiratory sound, is less intense, and lower in pitch. But if an inspiratory sound be alone present, the mixed quality and the elevation of pitch pertaining to the broncho-vesicular respiration suffice to mark the distinction. It may be in some instances a matter of question whether the respiration be broncho-vesicular or bronchial; but this is a point practically of little or no consequence, since the one merges insensibly into the other, and when there is room for doubt the bearing on diagnosis in either case is the same. The chief liability to error is connected with the question whether a broncho-vesicular respiration exists naturally, or is due to a morbid condition. To this point I shall presently advert.

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[1] "La distinction n'est pas toujours évidente entre la respiration *rude* et les formes de la respiration dite *puérile*, etc." Barth and Roger. Op. cit. Other writers make a similar statement.

As regards the morbid conditions to which broncho-vesicular respiration is incident, the respiratory sounds assume more or less of its character in some cases of emphysema. But in the great majority of instances it is connected with increased density of the lung, either from compression or morbid deposits. The conditions, in other words, are identical with those which give rise to the bronchial respiration; and the physical principles involved in its mechanism are the same, the only difference being that the vesicular murmur is partially, not completely suppressed. It is therefore met with in the same diseases which give rise to the bronchial respiration, viz., pleurisy and hydrothorax; compression of the lung by distension of the pericardial sac, and tumors; pneumonitis, tuberculosis, pulmonary apoplexy, œdema, and carcinoma. In pleural effusions (pleurisy and hydrothorax) it occurs early, when the quantity of liquid is small, the lung being subjected to moderate pressure, and again late in the process of these affections, when the liquid has been considerably reduced in quantity by absorption. In pneumonitis it may also be present at different epochs, first indicating a small amount of lymphatic exudation, and, afterward, its removal in a great measure; in the former instance giving place to, and in the latter succeeding the bronchial respiration. In general terms, it may be a sign of any of the several affections named, provided the condensation or solidification of lung be not sufficient to extinguish the vesicular murmur, in which case either the bronchial respiration appears, or all respiratory sound is suppressed.

The broncho-vesicular respiration is important, as a physical sign, chiefly in the diagnosis of pulmonary tuberculosis in its early stage. In this relation it is frequently a sign of great value. When the amount of tuberculous deposit is small, so far as the phenomena determinable by auscultation are concerned, this is the modification most likely to be produced; hence, in conjunction with other signs and symptoms, it is often very significant. In fact, the diagnosis may hinge upon the question whether a well-marked broncho-vesicular respiration be present or not. In this connection it is to be borne in mind (as has been stated already), that the several characters which distinguish this sign from the healthy vesicular murmur are by no means invariably present. More or less of these characters may be absent, as is the case with the bronchial respiration. The distinctive traits are nevertheless sufficient for its recognition. For example, an inspiratory sound only may be appreciable. If it be less vesicular, higher in pitch, and shorter in duration, together with a greater or less degree of intensity than the inspiratory sound at the summit of the chest, (where the tuberculous deposit first takes place,) at a corresponding point on the opposite side, the respiration is broncho-vesicular, as clearly almost as if there were added the characters pertaining to the expiratory sound. On the other hand, it is perhaps oftener the case that the sound of expiration exists alone, or at all events the distinctive characters may be more strongly marked by the presence of an expiratory sound on one side and not on the other, or a prolonged expiration on one side, in either case more intense than the sound of inspiration and higher in pitch, the reverse being the case on the opposite side, if an expiratory sound be appreciable on that side. These characters, irrespective of the inspiratory sound, denote a broncho-vesicular respiration.

In the diagnosis of tuberculous disease, before attributing to a morbid source the sign under consideration, we are always to inquire whether the phenomena may not be incident to a healthy condition; in other words, whether the points of disparity, which may be observed, do not rank among the variations which are frequently found in persons free from all pulmonary disease. This question, in some instances, gives rise to more room for difficulty and doubt, than a decision as regards the reality of the characters which distinguish the broncho-vesicular respiration. It has been seen under the head of Auscultation in Health, that the several elements into which the bronchial and the broncho-vesicular respiration are resolvable, are to be found in a certain proportion of healthy persons at the summit of the chest. This fact cannot be lost sight of without the risk of grave errors in diagnosis. Errors probably often occur from the want of a proper appreciation of this fact. The results of examinations of the chest in a series of healthy persons lead to a rule which affords great assistance in settling the question just mentioned. If the reader will refer to the comparisons of the regions at the summit of the chest in health, as respects the phenomena incident to respiration, he will see that comparative diminution of vesicular quality and elevation of pitch of the inspiratory sound, a more frequent presence of the sound of expiration with or without the inspiratory sound, prolongation of the latter with greater intensity and elevation of pitch, are points of disparity peculiar to the right side. In other words, a broncho-vesicular respiration is natural to the summit of the chest, in front and behind, in a certain proportion of individuals. This being the case, it follows that the question as to this modification of the respiratory sound being due to disease, pertains to its presence on the right side of the chest. A well-marked broncho-vesicular respiration on the right side may not indicate more than a natural disparity. To be considered a morbid sign, it must be associated with other signs, and with symptoms pointing emphatically to the existence of tuberculous disease. As an isolated sign, reliance must not be placed upon it in that situation. Non-observance of this rule exposes the practitioner to a false diagnosis. On the left side, however, the probabilities of the sign being due to a normal disparity are very few. In this situation, it is almost of itself positive evidence of a tuberculous deposit, when other circumstances create a suspicion of the existence of phthisis and it is of vastly less importance, with reference to the diagnosis, that it be associated with other signs, and with symptoms denoting the existence of tuberculous disease.

6. *Cavernous respiration.*—The term cavernous imports modifications of the respiratory sounds due to the presence of caverns or excavations within the chest. The formation of cavities of greater or less size, belongs to the natural history of tuberculosis of the lungs especially; they result from the production of abscess, as a very rare termination of pneumonitis; also from circumscribed gangrene, and from perforation establishing a fistulous communication between the bronchial tubes and the pleural sac. The cavernous respiration consists of the sounds caused by the entrance, with the act of inspiration, of air into the cavities incident to the several affections just named, and its expulsion with the act of expiration. Laennec described this sound as resembling that of the bronchial respiration, but distinguished by the air seeming to penetrate a larger space than that of a bronchial tube. The difference between the cavernous and the bronchial respiration, is certainly not very clearly defined in this description; and the two sounds are now considered by many to be essentially identical. Skoda advocates this view. The laryngo-tracheal sounds are frequently referred to by writers on this subject, as offering equally a type of the bronchial and cavernous respiration. This view does not seem to me to be correct. The cavernous respiration, I think, is a distinct modification, and, when well-marked, is

discriminated from the bronchial without difficulty, by characters which are quite distinctive. These characters relate to intensity, quality, pitch, and rapidity of evolution. The intensity is variable. It may be feeble, or more or less intense, but never acquiring the great intensity which sometimes characterizes bronchial respiration. It is rarely the case that it presents the character of the blowing respiration of Laennec, viz., the air appearing to enter and emerge from the ear of the auscultator. The quality of sound is non-vesicular, in other words blowing or tubular. It conveys to the ear the idea of a hollow space. The difference in this respect, between it and the bronchial respiration, may be illustrated by blowing, first, into a cavity formed by the two hands, and afterward through a tube formed by the fingers and palm of one hand. The pitch is low, compared with that of the tracheal or the bronchial respiration either of health or disease. An expiratory sound may be present, and if so, judging from a limited number of observations, the pitch is lower than that of inspiration.[1] Finally, it is evolved more slowly than the bronchial respiration; in other words, it does not so promptly accompany the beginning of the successive respiratory acts. Of the descriptive characters just mentioned, those which are specially distinctive, as contrasted with the bronchial respiration, relate to pitch of sound. The inspiratory sound is lower in pitch than in the bronchial respiration. The sound of expiration is lower than that of inspiration, the reverse obtaining in the bronchial respiration. This statement is based on a few observations, in which the phenomena were noted during life, the existence of cavities in the situations where these characters of the respiration had been studied,[2] being demonstrated after death.

In determining, clinically, the existence of the cavernous respiration, other circumstances than its intrinsic characters are to be taken into account. It is heard over a circumscribed area, which corresponds to the size of the cavity. It is an intermittent sign, being absent when the cavity is completely filled with liquid morbid products. Occurring, in the vast majority of the instances in which it exists, in the progress of tuberculosis, it is found at the summit of the chest; the cavities in that affection being formed at or near the apices of the lungs. It may be associated with other cavernous signs, to be noticed hereafter, viz., pectoriloquy, gurgling, and metallic tinkling.

[1] Vide cases in Appendix to Essay by the author, on Variations in Pitch, etc.

[2] Essay on Variations in Pitch, etc.

Frequently, the symptoms afford strong corroborative evidence of the existence of a cavity.

When a cavity, or cavities, exist in the lungs in connection with either of the affections which have been named, the presence of the cavernous respiration depends on certain conditions. The cavity must be empty, or, if partially filled, the opening or openings with which it communicates with the bronchial tubes, must be situated above the level of the liquid contents. Intermittency arises from the fact that, at different periods of the twenty-four hours, a cavity may be completely filled, partially filled, and entirely empty. It is less likely to be heard at an early hour of the morning, because liquid contents usually accumulate during sleep, and are removed by efforts of expectoration more or less prolonged, or repeated, after waking. The cavity, of course, must communicate by one or more openings with the bronchial tubes. The size of these openings will affect the sign; in the first place, directly, the intensity of the sound, other things being equal, being proportionate to the freedom with which the air is admitted to the cavity; and, in the second place, indirectly by favoring the removal of the liquid contents by expectoration. The opening or openings, are liable to become temporarily or permanently obstructed. Their form and size sometimes are such, that the current of air in passing to and fro, gives rise to adventitious sounds, which render the cavernous respiration inappreciable. The bronchial tubes leading to the cavity must be unobstructed, and free from loud adventitious sounds, which are frequently generated within them. The walls of the cavity must not be so rigid and unyielding as not to collapse and expand with the alternate acts of inspiration and expiration; otherwise, it will not be successively filled with and emptied of air. The cavity must be of a certain size, and, other things being equal, the cavernous respiration will be marked in proportion to its magnitude. The presence of the sign will depend on the situation of the cavity. Situated superficially, or near to the exterior of the lung, the sound may be appreciable when it would not have reached the ear through a layer of pulmonary parenchyma.

The condition of the lung surrounding, or in the vicinity of, the cavity is an important circumstance. Generally there is more or less solidification, giving rise to the bronchial respiration. This sometimes assists by contrast in determining the presence of a cavernous respiration, but in other instances it drowns the latter and prevents it from being appreciated. In consequence of its dependence on so many contingencies, it is only in a small proportion of the cases in which a cavity or cavities exist, that auscultation succeeds in discovering a well-marked cavernous respiration; and frequently in the instances in which it is discoverable, it is found only after repeated explorations. Fortunately, as a physical sign, it is of less importance practically than other signs involved in the diagnosis of the affections to which the formation of cavities is incident.

A successful search for a cavity requires considerable care and patience. The object is to localize within a circumscribed space a non-vesicular respiration, with an inspiratory sound low in pitch, evolved somewhat slowly, and an expiratory sound, if present, lower in pitch than the inspiratory. Perhaps, to these differential characters should be added a certain hollow quality, giving the idea of air entering into a cavity, which constitutes the distinctive feature, according to most of the writers who recognize a cavernous sound intrinsically distinct from the bronchial. The lowness of the pitch of inspiration compared with the bronchial respiration is mentioned by Walshe and others; but the relative lowness of the pitch of expiration compared with the inspiration, has not to my knowledge, been before pointed out. As I have been careful to state, this relation, as regards pitch of the inspiratory and expiratory sounds, is based on a few observations only, in which, however, the results were positive. If this relation be uniform, it must be considered to constitute a highly distinctive characteristic of the cavernous, as distinguished from the bronchial respiration; and it is rendered especially important by the fact that other signs of a cavity, formerly considered to be distinctive (I refer more particularly to the vocal sign, pectoriloquy), have now justly ceased to be regarded in that light. The fact of a blowing sound being restricted within a circumscribed space, is by no means reliable as sufficient evidence that the respiration is cavernous. They, who consider the bronchial and cavernous respirations identical in character, are obliged to base the discrimination on that circumstance. But a bronchial respiration, at the summit of the chest, is not unfrequently circumscribed within narrow limits; hence, errors of diagnosis are necessarily incident to reliance on this point. Fournet confesses that he has fallen into this error. He says: "Dans ces cas, il est facile de prendre le caractère bronchique, pour le caractère caverneuse: je m'y suis d'abord trompé quelquefois. . . . . . j'étais étonné, à l'autopsie de ne pas rencontrer la plus petite trace de cavernes." Op. cit. p. 101. I have known mistakes arising from this source to be committed by experienced auscultators. Taken, however, in connection with other points, it is of considerable importance; and in order better to circumscribe the area whence sounds are received by the ear, the stethoscope should be used in preference to immediate auscultation. To determine the non-vesicular quality of the sound at a suspected point, a comparison[1] may be made of the sound at this point with that heard over portions of the chest where the vesicular quality is distinctly preserved. To determine that the pitch is lower than that of the bronchial respiration, in cases of tuberculosis, the sound at a suspected point may frequently be contrasted with that at other points at the summit of the chest, where, owing to the presence of crude tubercle, the bronchial respiration is well marked. Or, if this comparison be wanting, it may be contrasted with the sounds heard over the trachea. In some instances, owing to the cavity being surrounded by solidified lung, the cavernous respiration will be presented in strong contrast to the bronchial respiration, which on all sides defines the boundaries of the excavation.

In one of the cases in which I succeeded in localizing a cavity, the following interesting circumstance was noticed. At the beginning of the inspiratory act the sound was tubular and high in pitch, but at about the middle of the act the pitch abruptly became low, the blowing quality being still preserved. The inspiration was followed by a feeble expiratory sound low in pitch. In this case, a post-mortem examination revealed a cavity communicating at the point where this peculiarity was observed with a bronchial tube of the size of a goose-quill.[2] This instance exemplified a combination of the cavernous and bronchial respiration.

Of the several affections in which a cavernous respiration may be observed, tuberculosis, as already remarked, is the one in which it occurs in the vast majority of instances. All the other affections are extremely rare. In circumscribed gangrene and abscess moreover, the conditions required for the production of the sign, are much more unfrequently combined than in the cavernous stage of phthisis. Skoda states that in the few instances in which an excavation results from pneumonitis, the space is so constantly filled with pus and sanies, that it almost never gives rise to distinctive sounds, determinable either by percussion or auscultation. In pneumo-hydrothorax the pleural sac, which may be more or less circumscribed by morbid adhesions, constitutes a cavity in which the air may enter with inspiration, and be expelled with expiration, through the fistulous communication with the bronchial tubes. There is still another mode in which a cavity may be formed within the chest, viz., by means of a pouch-like dilatation of a bronchial tube. This is exceedingly unfrequent, but it is to be borne in mind as a possible condition giving rise to the sign under consideration. In view of the vastly greater ratio of tuberculous excavations to those incident to all other affections, when the fact of the existence of a pulmonary cavity is determined, it might be attributed to phthisis, almost by the law of probabilities alone; but the situation of the cavity affords additional evidence. A tuberculous excavation in forty-nine out of fifty cases is situated at or near one of the apices of the lung, while, on the other hand, cavities from gangrene, abscess, or perforation, are more likely to occur elsewhere.

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[1] There will be a liability, in certain cases, without due attention to the vesicular quality, to mistake an exaggerated vesicular respiration for the cavernous. I have cautioned against this liability in another work (Prize Essay), yet it has been illustrated in a case which recently came under observation, in which all the external characters of advanced phthisis were presented, and the exploration was limited to the summit of the chest. The patient had double pleurisy, with considerable effusion in both pleural cavities; under these circumstances, the superior costal respiratory movements were strongly marked, the percussion resonance was tympanitic, and on auscultation, an intense inspiratory sound was heard, followed by a prolonged expiration, lower in pitch than the sound of inspiration. The respiratory sounds were manifestly not bronchial, and were incorrectly supposed to be cavernous. An autopsy disclosed double pleurisy with effusion, and a few small disseminated tubercles.

[2] Vide Appendix to Essay on Variations in Pitch, etc.

As a sign indicating the nature of the disease, in individual cases, cavernous respiration is of minor importance. It is discoverable in but a small proportion of the cases in which cavities exist. Tuberculous excavations are very frequent. They are found after death in most subjects dead with phthisis, and the prevalence of this fatal disease in all countries is well known. Yet it is rather rare in cases of advanced phthisis, to be able to discover a well-marked cavernous respiration, even after repeated, careful explorations. And when cavities are formed in the progress of any of the affections named, but especially in tuberculosis, occurring at a late period of the disease, the diagnosis has already been determined by other signs, together with the concomitant symptoms; hence a cavernous respiration only serves to confirm its correctness. Moreover, in each of these affections, excepting, perhaps, pouch-like dilatation of the bronchia, the signs and symptoms, irrespective of cavernous respiration, are sufficient to render the diagnosis easy and positive, so that the latter is redundant, and except as a matter of scientific interest, hardly compensates for the pains necessary to discover it.

An abnormal modification of the respiratory sound, called *amphoric respiration* or *metallic echo*, is by some writers considered a distinct physical sign. It is incident to a cavity equally with the cavernous respiration, and both are sometimes combined, although the mechanism of their production is not the same. But for all practical purposes it suffices to regard the amphoric, as a variety of the cavernous respiration. If a person blow gently into an empty vessel, for example a decanter, or water-croft, a sound is produced which has a musical intonation. This sound is analogous to that which characterizes the amphoric respiration; in other words, whenever a blowing respiratory sound presents a silvery or metallic tone it is said to be amphoric. A still more perfect imitation is afforded by blowing into a fresh bladder, after it is inflated to a considerable degree of tension, while in contact with the ear. This peculiar sound is variable as regards intensity. It has been heard even when the ear is removed at a little distance from the chest. It is generally confined to a circumscribed space, but is sometimes diffused more or less over the chest. It may accompany either respiratory act, but according to Barth and Roger is most apt to attend the act of inspiration.[1] The mode of its production within the chest is probably the same as in the illustration mentioned. It is not caused by the free circulation of air within a cavity, but by the current of air in the bronchial tubes, acting upon the air contained within the cavity. In this respect it differs from ordinary cavernous respiration. The special conditions which it requires are, a cavity of considerable size, of course free from liquid contents, partially or entirely, and the walls of the cavity sufficiently firm not to undergo complete contraction and dilatation with the alternate acts of inspiration and expiration. In some instances a partial displacement of air takes place in consequence of a certain amount of collapse and expansion of the walls of the cavity, and then, there may exist a true cavernous respiration with the amphoric sound superadded.

The amphoric respiration may occur in connection with any of the affections which give rise to cavities. It is exceedingly rare, however, that an excavation, except it proceed from tuberculous disease, is of sufficient size and provided with walls sufficiently firm to fulfil the requisite physical conditions. It is a very unfrequent phenomenon in tuberculous disease. The conditions are most likely to exist in pneumo-hydrothorax; and hence, when the sign is present it generally denotes that affection. It is stated by Skoda that for the production of an amphoric sound, a free communication between the bronchial tubes and the pleural sac or a pulmonary excavation is not necessary. He thinks that the sonorous vibrations may be communicated to the air contained within the cavity, by the column of air in the tubes, through an intervening septum of pulmonary tissue. This opinion, as remarked by Barth and Roger, is supported by the fact that the experiment of producing an analogous sound by blowing into a decanter or water-croft, is successful when the mouth of the vessel is covered by a very thin diaphragm, for example a single layer of letter paper. The sound, under these circumstances, is more feeble, and more force in blowing is required.

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[1] Dr. Walshe states the reverse of this, viz., that it especially accompanies expiration. Fournet makes the same statement.

Amphoric respiration when present, indicates very positively either pneumo-hydrothorax, or the existence of a large cavity within the lungs. Its absence, however, is not evidence that one or the other, or both morbid conditions do not exist. This remark, which is applicable to ordinary cavernous respiration, is still more so to the amphoric variety. Considering its infrequency, and in view of the fact that the diagnosis of the affections, in connection with which it occurs, is in no wise dependent upon it, the sign is interesting more as a clinical curiosity than for its practical value.

The three forms of morbid respiration just considered, viz., the bronchial, the broncho-vesicular, and the cavernous, constitute the subdivisions of the class of auscultatory phenomena embracing abnormal modifications in quality, pitch, etc., of the normal respiratory sounds. In place of a summary of the distinctions which have been described in the preceding pages, the subjoined tabular view is appended, by means of which the reader may review, at a glance, the distinctive characters pertaining to the three forms of morbid respiration just mentioned, and compare them with the characters which belong to the healthy vesicular murmur.

Tabular View of the Distinctive Characters pertaining to the Different Abnormal Modifications in Quality, Pitch, etc., of Respiratory Sounds.

NORMAL VESICULAR MURMUR.

Inspiration.	*Expiration.*
Vesicular in quality. Low in pitch. Longer than expiration as 5 to 1.	Short in duration, averaging about 1-5th length of inspiration. Less intense than the inspiration. Often absent. Pitch lower than that of inspiration. Inspiration and expiration continuous.

BRONCHIAL RESPIRATION.

Inspiration.	*Expiration.*
Tubular in quality. Pitch raised. Shortened in duration. Rapidly evolved.	Prolonged; frequently as long or longer than the inspiration. Generally more intense than the expiration. Rarely absent. Pitch higher than that of the inspiration. An interval between inspiration and expiration. Sometimes present without inspiration.

BRONCHO-VESICULAR RESPIRATION.

Inspiration.	*Expiration.*
Tubular and vesicular qualities mixed. Pitch raised. Duration frequently shortened.	Prolonged. Generally more intense than the inspiration, and the pitch higher. Usually present. Pitch somewhat higher than that of inspiration. An interval between inspiration and expiration. Sometimes present without inspiration.

CAVERNOUS RESPIRATION.

Inspiration.	*Expiration.*
Blowing or non-vesicular in quality. Pitch low. Slowly evolved.	Feeble. Frequently absent.(?) Pitch lower than that of inspiration.

The remaining division of the modifications in quality, etc., of respiratory sound comprises those relating to rhythm. The subdivisions under this head, save one, are among the constituent elements of modifications included under other divisions, and have been already considered. A brief notice of them will therefore suffice in the present connection. The modifications in rhythm which are of importance in diagnosis are three in number, viz., 1, shortened inspiration; 2, prolonged expiration; 3, interrupted respiration. The two first have received attention in connection with exaggerated, feeble, bronchial, and broncho-vesicular respiration.

7. *Shortened inspiration.*—Abnormal shortening of the inspiratory sound, occurring as one of the elements entering into modifications which have been considered, is of two kinds. As it is presented in the feeble respiration incident to emphysema, it forms what is called *deferred* inspiration. The inspiratory sound does not commence prior to the middle or toward the close of the inspiratory act. Hence the propriety of the term deferred. With the ear applied to the chest, the expansive movement is frequently felt for some time before any sound is appreciable. The healthy vesicular murmur is heard in health with an intensity increasing from the beginning to the end of

the inspiratory act. When, therefore, the sound becomes abnormally feeble in emphysema, it is inaudible until the intensity increases to a certain point. In this way, with the progress of the disease, it is in some instances at length extinguished; the suppression extending more and more towards the end of the act of inspiration, until the sound entirely disappears. The duration is diminished in a different manner in the bronchial and the broncho-vesicular respiration. The sound is quickly evolved, commencing nearly at the commencement of the act of inspiration, and ends before the close of the act. The inspiratory sound in this case, is said to be *unfinished*. The difference in these two forms of shortened inspiration, it will be observed, corresponds to the difference as respects the situation in which the sound is generated. A vesicular inspiratory murmur when shortened, is deferred; a shortened bronchial inspiration is always unfinished. Another point of distinction is involved in the foregoing, viz., a shortened bronchial or unfinished inspiration is, at the same time, notably changed in quality and pitch; a shortened vesicular or deferred inspiration offers much less change in other respects. To treat of the diagnostic significance of this rhythmical modification, would be to repeat what has been already fully presented.

As the consequence of an unfinished inspiration, an interval occurs between the inspiratory and the expiratory sounds. The duration of this interval is proportionate to the extent to which the inspiration is shortened. Regarding this as a distinct modification of rhythm it is called *divided* respiration. Division of the two sounds of respiration is one of the several elements of the bronchial and the broncho-vesicular respiration. It is a change, however, entirely dependent on the unfinished duration of the inspiratory sound, and it suffices to notice it as incidental to the latter.

8. *Prolonged expiration.*—Although Laennec did not overlook the fact of the existence of an expiratory sound in health, the importance of its abnormal modifications escaped the attention of the illustrious discoverer of auscultation. His observations of the phenomena of disease referable to modified respiratory sounds, were confined to those produced by the inspiratory act. The honor of having first called attention to the value of the expiration in physical diagnosis belongs to an American physician, arrested by the hand of death at the threshold of a career of useful labor in behalf of medical science. In 1833, Dr. James Jackson, Junr., of Boston, at that time prosecuting his studies in Paris, communicated a paper

to the *Société Médicale d'Observation*, on the subject of a prolonged expiratory sound as an early and prominent feature of the bronchial respiration, and frequently constituting an important physical sign of the first stage of phthisis. From this epoch may be dated the commencement of observations which have rendered the expiratory scarcely inferior to the inspiratory sound, in its relations to the distinctive characters of the bronchial, the broncho-vesicular, and the cavernous respiration. The reader has only to glance at the tabular view of the characters distinguishing severally the modifications just mentioned, to perceive the importance of the abnormal changes in duration as well as in the intensity and pitch of the sound of expiration. A prolonged expiration has been also seen to enter into the characters distinguishing exaggerated respiration, and to constitute a striking feature of the opposite, viz., feeble respiration as exemplified in certain cases of emphysema.

Differences in other particulars than duration, and especially variations in pitch, are important to be considered in connection with prolongation of the inspiratory sound. Thus, in bronchial respiration, the expiration, while it is increased in length, is more intense and higher in pitch than the sound of inspiration. The same difference holds good, to a greater or less extent, in broncho-vesicular respiration. On the other hand, in cavernous respiration, the expiratory sound is more feeble and lower in pitch than the sound of inspiration. In exaggerated respiration, the expiration is also less developed than the inspiration, and the relatively lower pitch which exists in normal respiration is preserved. The same is probably true of the prolonged expiration in emphysema; at all events, it does not present the elevation of pitch which characterizes the expiratory sound in bronchial respiration.[1] These variations in the pitch of the expiratory sound have hitherto been but little studied, and their significance has, therefore, not been sufficiently appreciated. They appear from the facts just stated to sustain relations to the differences in the physical conditions under which the duration of the expiratory sound is increased, which it is both interesting and important to note. When the pitch is raised in the bronchial and the broncho-vesicular respiration, the prolongation is due to increased density of lung; while in exaggerated respiration there is no morbid change in the part of the lung whence the sound emanates, but simply an increased functional activity, and under these circumstances the pitch is not raised, but continues as in health, lower than that of the inspiration. In emphysema, owing to the diminished elasticity of the lung, the cells collapse and expel their contents more slowly than in health. In this case the pitch is not notably, if at all raised. The same will be true when the prolongation is due simply to any obstruction to the passage of air from the cells to the larger bronchial tubes. If this view of the subject be correct, and observations will, I believe, be found to confirm its correctness, the pitch of sound, taken in connection with increased duration, affords a means of determining whether the latter is an indication of tuberculous or other morbid deposit, or only of a retardation of the reflux current of air from the cells.

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[1] The prolonged expiration in emphysema often assumes a high-pitched tone in consequence of co-existing bronchitis. Under these circumstances it ceases to be, properly considered, a modified respiratory sound, but becomes a *râle*. This distinction is to be observed in verifying by observation the statement made above.

A prolonged expiratory murmur in some instances is the sole or chief alteration of the respiration which an examination of the chest discloses, the inspiratory sound not presenting any distinct morbid change in vesicular quality, intensity, pitch, or duration. Now, what is the diagnostic value of a prolonged expiration under such circumstances? The importance of this question relates to its practical bearing on the diagnosis of incipient phthisis. Is a prolonged expiration under the circumstances assumed, to be regarded as a sign of tubercle? These inquiries suggest some considerations to which I will devote a little space. The earliest and most obvious of the auscultatory evidences of tubercle, in a certain proportion of cases, undoubtedly, are incident to the expiration. On this point, the observations of Dr. Theophilus Thomson are interesting.[1] This author states that among 2000 consumptive patients, a prolonged expiratory murmur was the most remarkable of the physical signs in 288, or a proportion of about one to seven. In a large majority of these cases, the concomitant signs and symptoms were not such as to render the diagnosis positive; and, hence, Dr. Thomson is led to conclude that a prolonged expiratory murmur frequently takes precedence of other characteristic signs; an opinion according with that advanced by Jackson, in his memoir on this subject. But a prolonged expiratory murmur is found to exist frequently in the healthy chest. This is shown by the results of a series of examinations given under the head of Auscultation in Health. A certain allowance is to be made for this fact, which was not ascertained when Jackson first called attention to the importance of the expiration in diagnosis, and hence, he was naturally led to overrate the intrinsic significance of the sign under consideration. There is reason to suspect that in some of the cases examined by Dr. Thomson the prolonged expiration may have been a natural peculiarity. The subjects were the out-patients of an hospital, and it is not stated how large a proportion remained under observation till the evidences of tuberculous disease were unequivocally declared. A naturally prolonged expiration, however, occurs only on the right side. The question whether it be natural or morbid, therefore, arises only when it is found on the right side. Existing on the left, and not on the right side, the significance is vastly greater than when the reverse is the case, or it is found on both sides. It is needless to say that its significance as a sign of tubercle depends on its situation at the summit of the chest. If it exist more or less over the entire chest on one side, still more on both sides, it is due to other causes than tuberculous disease, and, if not natural, probably denotes emphysema. The more circumscribed the space over which it is heard at the summit, the greater the diagnostic evidence of tubercle. The evidence, also, is enhanced if it be found in a circumscribed space in the infra-clavicular region at some distance from the point at which the normal bronchial respiration is to be sought for, and is more marked than in the latter situation. Finally, the elevation of pitch is to be taken into account. If the pitch be not raised, it indicates only obstruction, which, it is true, may be incident to tubercle, but inasmuch as other causes may induce obstruction, the evidence of phthisis is less if the pitch remains unaltered. Among cases in which a tuberculous deposit actually exists, it must be exceedingly rare that the diagnosis hinges exclusively on a prolonged expiration. It would certainly be unsafe ever to base a positive diagnosis on this sign alone. In conjunction with other signs, however, and with symptoms, observing the cautions just mentioned, it is entitled to considerable weight. In a large proportion of cases, it is associated with more or less of the other characters of the bronchial, or the broncho-vesicular respiration, of which modifications, when it co-exists with tubercle, it is to be regarded as a constituent element.

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[1] Clinical Lectures on Pulmonary Consumption.

It is necessary to caution the inexperienced auscultator against mistaking for a prolonged expiratory murmur the sounds originating in the mouth, throat, or nasal passages, entering the ear not applied to the chest, and appearing to come from the chest.

9. *Interrupted respiration.*—This rhythmical aberration has re-

ceived several names, such as *jerking*, *wavy*, *cogged-wheel*.[1] The sound instead of being continuous, is broken into one or more parts. It may be imitated in the mouth by drawing in the breath with a series of disconnected inspiratory efforts, instead of a single uniform act of inspiration. It is very rarely observed with expiration.

The inspiratory sound may be interrupted in connection with various affections, which may be arranged into two classes, according to the mode in which they produce this phenomenon. In one of these classes the interruption takes place in consequence of a corresponding want of continuousness in the expansive movements of the thoracic walls. This occurs in pleurisy, pleurodynia, and intercostal rheumatism, in consequence of the pain occasioned by expanding the chest. The patient instinctively, as it were, shrinks from the movements necessary to hæmatosis, and hence an irregular series of efforts instead of a steady expansion. Thus produced, an interrupted inspiratory sound will pervade the entire chest. In the other class, the cause is seated in the pulmonary organs. In the latter case the sign is limited to a part of the chest. When the cause is pulmonary, it is of a nature to oppose an obstacle to, but not to prevent, the free expansion of a portion of the lungs. Partial obstruction of a bronchial tube, either from spasm, tuberculous deposit, or bronchitis confined within circumscribed limits, is probably competent to produce this effect. Adhesions of the pleura, also, may involve the necessary physical conditions.

This exists as a normal peculiarity in a certain proportion of individuals, who, irrespective of this sign, are apparently free from pulmonary disease. I met with it in two of twenty-four examinations. I have observed it on the healthy side in lobar pneumonia. Incident to health, it is sometimes a transient or intermittent peculiarity, but in some instances is persistent. In health or disease it is oftener observed on the left, than on the right side, and is rarely found, exclusive of the cases in which it extends over the whole chest, elsewhere than at the summit in front.

The importance of this sign practically may be said to have reference solely to the diagnosis of incipient phthisis. Observations show that it is present not infrequently in cases of tuberculous disease, at an early period, while the associated physical indications are slight. Under these circumstances it may, in some instances, be due to the obstruction caused either by the pressure of the tubercles on the bronchial tubes, or by circumscribed bronchitis; and in other instances to mechanical restraint exterior to the lungs, such as is incident to pleuritic adhesions. Its significance or value as a diagnostic sign of phthisis, of course depends on the frequency with which it is observed in that affection, and its infrequent occurrence in health, or in connection with other forms of disease. Dr. Theophilus Thomson, who has made this sign the subject of special statistical research, recorded 105 cases in which it was found to be present.[1] Of these cases, in 32 there were grounds, irrespective of this sign, for suspecting tuberculous disease. Of the remainder, many were entirely free from other evidences of any affection of the lungs. Dr. Thomson adds that in several instances he has watched the persistency of this sign for years without its becoming complicated with any other indication of disease.

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[1] Called by Laennec *inspiration entrecoupée*, and by French writers of the present day *respiration saccadée*.

In view of these facts an interrupted inspiratory sound cannot be considered to afford more than a certain amount of presumptive evidence of phthisis. As an isolated sign it is entitled to but little weight. Associated with other signs, such as dulness on percussion, prolonged expiration, etc., being present at the situation where the latter are observed, and this situation being a circumscribed space at the summit of the chest, it adds to the amount of collective proof of the existence of a tuberculous deposit.

2. ADVENTITIOUS RESPIRATORY SOUNDS.—Thus far, in treating of the phenomena incident to respiration, the abnormal sounds which have been considered are modifications of those which pertain to the respiratory apparatus in health. It remains to consider certain phenomena which have no existence in the healthy chest, and are therefore distinguished as new or adventitious sounds. The greater part of these sounds originate either in the air-tubes, the vesicles, or within cavities formed in the lungs. Some are produced exterior to the pulmonary organs between the pleural surfaces. The latter are termed *attrition* or *friction sounds*. Different names are employed to designate the former. Laennec applied to them the word *râles*, which is still in vogue with the French, and also with medical writers, and in conversational language, to a considerable extent in other countries than France. Other names by which they are collectively distinguished are *rhonchi* and *rattles*. The two latter terms are not

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[1] Op. cit. p. 161.

only wanting in euphony, but their signification is inappropriate when applied to some of the sounds embraced in this class. In the absence of a satisfactory substitute either of classical derivation, or from our own language, it seems to me preferable to retain the title adopted by the discoverer of auscultation. I shall accordingly make use of the term *râle* in the sense in which it was employed by Laennec, viz., to denote any abnormal sound produced with the acts of respiration in the air-tubes and vesicles of the lungs, or within cavities formed in these organs.[1] Proceeding at once to a consideration of the rales, the points to be first settled are, the number which are to be recognized as constituting individual signs; the method of classification, and the appellations by which they are to be distinguished severally from each other. Laennec determined the rales by their audible characters, and designated them after resemblances to other well-known sounds. Most of the rales discovered by him are still recognized, and the same appellations are generally retained. Andral proposed to divide the rales after their anatomical location in the air-tubes, vesicles, or cavities, and to distinguish them from each other by their conveying to the ear the sensation either of the presence or absence of liquid, the former being called moist, and the latter dry rales.[2] As a basis of classification this is convenient and advantageous. The appellations, however, in common use since the time of Laennec will continue to be employed, and they are so interwoven in medical literature that it would be undesirable to endeavor to substitute others, even were they in some respects preferable. Following, then, the plan of distribution according to situation, certain rales are produced within the air-tubes, the larynx, trachea, the two bronchi, and the subdivisions of the latter. Those produced within the larynx, trachea, and two bronchi, may be arranged into one class, and embraced under the denomination of *Tracheal Rales.* Tracheal rales may be dry or moist. The latter proceed from mucus or other liquid collected in the portions of the air-tubes just named. As a general remark, they occur, excepting when they are transient, only as an effect of the movements necessary to expel morbid products from these situations becoming ineffectual, from blunted perception and defective muscular power. The tracheal rales are therefore characteristic of the moribund state, or indicate generally that this state is nigh at hand. Constituting what is popularly known as the "death rattle," they are sufficiently loud to be heard often at a considerable distance, and indicate to the ear the presence of liquid. They are exaggerated types of certain of the moist rales produced within the pulmonary air-tubes. Dry rales may be produced within these sections of the air-passages when there exists contraction at the glottis from spasm, œdema, exudation of croup, etc.; or when, from the pressure of a tumor, the presence of a foreign body, morbid deposits or growths, the calibre of the tube is sufficiently diminished at a point below the glottis. They consist of wheezing, whistling, or crowing sounds, more or less intense, which may be audible at a distance, without stethoscopic examination. These sounds also represent, on a large scale, the dry rales produced within the pulmonary organs, and involve similar physical conditions. Auscultation of the larynx or trachea will sometimes reveal dry rales not otherwise audible, and, in either case, may be useful in determining the precise seat of an obstruction. Rales produced within the larynx or trachea may be propagated to the chest and heard in the latter situation. It is, therefore, necessary sometimes to auscultate the larynx and trachea in order to determine whether sounds heard over the chest are transmitted from these sections of the air-tubes. It is chiefly in the two points of view just named, that tracheal rales are of importance in diagnosis.

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[1] If the French term *râle* be adopted, it should, I think, be anglicised, and I shall hereafter use it as an English word.

[2] Skoda restricts the application of the term rale to the sounds produced by liquid. The dry rales he calls simply sounds. The latitude of signification accorded to the rales, may, however, be settled fairly by conventional usage, and there is a convenience in a generic term applied to all new or adventitious sounds.

Adventitious sounds produced within the pulmonary subdivisions of the bronchi are called the *Bronchial Rales*. These are of two kinds, the one, indicating by the character of the sound, the presence, and the other, the absence of liquid in the bronchial tubes. The former are called moist, and the latter dry rales. The dry bronchial rales are subdivided into two varieties, called the *sibilant* and *sonorous*. The distinction between the sibilant and sonorous rales consists mainly in a difference of pitch. A sibilant rale is high-pitched, and as the name imports, is a whistling or hissing sound. A sonorous rale is low or grave in tone. The former, in general, is produced in the smaller, and the latter in the larger bronchial tubes. Both are sometimes distinguished as the *vibrating* rales. Most of the moist bronchial rales are usually styled *mucous rales*, the liquid concerned in their production being generally mucus. They are, however, produced equally by other fluids, viz., pus, softened tuberculous matter, serum, or blood. They are subdivided into coarse and fine rales. The sound in the former instance conveying to the ear the idea of large, and in the latter of small bubbles. These variations are found to correspond to differences in size of the bronchial tubes in which the sounds are produced. In contrast with the term *vibrating*, applied to the dry rales, the moist are sometimes called *bubbling* rales.

A moist rale produced in the minute bronchial divisions, but not in the capillary bronchiæ, is distinguished as a *sub-crepitant rale.* The significance of this title is derived from resemblance to a sound produced within the vesicles, to which reference will shortly be made. The sub-crepitant is an important variety of the moist bronchial rales.

The only rale positively attributed to the air-vesicles is called the crepitant or crepitating; so called from the peculiar character of the sound. This is a highly important physical sign.

Gurgling is a name applied to a peculiar sound produced by bubbling, and the agitation of liquid contained in a cavity of considerable size. By some, however, it is considered as simply a variety of mucous rale.

In addition to the several rales just enumerated, there are certain sounds occasionally heard, undetermined as regards their location and the mode of their production, as well as somewhat varied in character. These may be embraced under the title *indeterminate rales.*

By reference to the subjoined tabular view, the reader will be able to see at a glance, the number and names of the several *pulmonary* rales, which are to be subsequently considered, arranged in the order in which they have just been briefly described.

Table showing the Number, Names, and Anatomical Situations of the Pulmonary Rales.

1. Bronchial.	
a. Dry, or vibrating.	1. Sibilant rale. 2. Sonorous rale.
b. Moist, mucous, or bubbling.	1. Coarse mucous rale. 2. Fine mucous rale. 3. Sub-crepitant rale.
2. Vesicular.	
1. Crepitant rale.	
3. Cavernous.	
1. Gurgling rale.	
4. Indeterminate.	
1. *Râle crépitant sec à grosses bulles*, of Laennec.	
2. Pulmonary crumpling.	
3. Pulmonary crackling.	

1. *Sibilant rale.*—Any bronchial sound, not a modification of the normal respiration, in other words, any adventitious sound or rale, which conveys to the ear the sensation of dryness, and is acute or high-pitched, falls under this denomination. Frequently the sound has a musical tone, resembling sometimes the cry of a young animal, the chirping of birds, etc. In other instances, it is a sharp, clicking sound. Occasionally it is not unlike the whistling of wind through a crevice or key-hole. Without any uniformity as respects tone, or resemblance to particular well-known sounds, a sibilant rale is characterized by its apparent dryness and elevation of pitch. With this definition, notwithstanding its diversities, it is appreciated without difficulty. The respiratory murmur may continue to be heard, the rale being superadded, or the former may be masked by the latter. It may accompany the inspiratory or the expiratory act, oftener the former when confined to one, but it sometimes attends both acts.

A sibilant rale is frequently variable, occurring not with each successive respiration, but at irregular intervals, continuing perhaps for a few moments, then ceasing, and again reappearing. It is variable as regards intensity, as well as other characters. It may be often suspended by an act of coughing. It is apt to vary also in situation, being heard at one moment in a certain part of the chest, and the next moment in another part; thus changing its seat, it may be, frequently, within a short space of time. The rale may be more or less diffused over the entire chest, or confined to one side, or, again, limited to a circumscribed space.

The sibilant rale is produced within the smaller branches of the bronchial tubes. This is the rule, with perhaps exceptional instances in which it originates in the larger bronchiæ in consequence of their calibre being diminished by morbid changes. Laennec attributed its production to the space within the tubes becoming contracted at certain points by swelling of the mucous membrane. From its variability, however, and the fact that it frequently disappears after an act of coughing, it is probably due in many if not most instances, to tenacious mucus adhering to the walls of the tubes with sufficient firmness to occasion a partial obstacle to the current of air, and give rise to sonorous vibrations without bubbling. This explanation is sustained by the fact that the rale is observed especially at the commencement of inflammation of the mucous membrane lining the smaller tubes, when the mucus secreted is small in quantity and adhesive. The swelling of the membrane, greater in some portions than in others, reducing thereby the capacity of the tubes, not uniformly, but irregularly, may, it is probable, give rise to dry rales, which, under these circumstances, are more persistent. Spasm of the muscular fibres also induces the requisite physical conditions. So, also, pressure of a tumor on the tubes, diminishing their size, and changing their direction, but not sufficiently to produce obstruction.

In the majority of instances a sibilant rale is a sign either of catarrh or bronchitis seated in the smaller tubes. If it be heard more or less over the chest on both sides, associated with certain symptoms, febrile movements, etc., the evidence is very strong of the early stage of capillary bronchitis occurring as a primitive affection; for bronchitis is one of the symmetrical diseases, which is not true, to the same extent, of diseases in which bronchitis is liable to occur as a contingent affection. On the other hand, if it be confined to one side of the chest, it may be due to bronchitis occurring as a secondary affection, for example, in connection with pneumonitis or pleurisy. If it be restricted to a circumscribed space at the summit of the chest on one side, taken in connection with other facts, it inferentially points to the existence of phthisis; for circumscribed capillary bronchitis rarely occurs except in the immediate vicinity of a tuberculous deposit, and it is at the summit of the chest, near the apex of the lung, that this deposit takes place. The sign is present in a marked degree in asthma proceeding from spasm of the bronchial tubes, generally associated with pulmonary catarrh or bronchitis; and it is still more marked if the catarrh or bronchitis occur in connection with emphysema. Under the circumstances last mentioned, it is most prominent in the expiration, owing to the same causes which occasion a prolonged expiratory murmur, viz., impaired elasticity of lung, and the necessity of increased muscular power to expel the air from the over-distended cells. Although, therefore, the presence of the sign generally denotes inflammation of the mucous membrane lining the smaller tubes, or irritation bordering on an inflammatory state, the diagnosis would often be incomplete were not other signs taken into account, as well as symptoms which disclose the coexistence of other affections, viz., pneumonia, pleurisy, tubercle, and emphysema. It is only after excluding these several affections by the absence of their diagnostic criteria, that the sign denotes a morbid condition pertaining solely to the bronchial tubes.

2. *Sonorous rale.*—This expression, which the French apply to all the dry bronchial rales, by English writers is limited to those dis-

tinguished from the sibilant rale by gravity of tone. A sonorous rale may be defined to be any dry adventitious sound produced within the bronchial tubes, not acute or high in pitch. The exact line of demarcation between the sibilant and sonorous rales cannot be defined in words, nor is it necessary to make the distinction with rigorous exactitude in practice. Sonorous rales are due to the same physical conditions as the sibilant, the only difference as regards their production pertaining to location. They proceed from the larger bronchial tubes. In their audible characters they are not more uniform than the sibilant rales. Among the diversity of sounds to which they may be compared are the snoring of a person sleeping, heard at a distance, the humming of a musquito, the cooing of a pigeon, a note of a bass-viol or bassoon, etc., etc. The tone is oftener more distinctly musical than that of the sibilant rales. The sound is also louder and stronger, being sometimes heard at a distance, without auscultation, and producing a vibration or thrill perceived by placing the hand on the chest.

The remarks in connection with the sibilant rale as to variableness of intensity and peculiarity of tone, change of place, cessation and reappearance, and suspension by acts of coughing, are equally, and, indeed, even more applicable to the sonorous rale. Like the sibilant, the sonorous rale may accompany either act of respiration, or both acts. When confined to one, it is more apt to be produced by expiration, in this particular differing from the sibilant rale.

Sonorous rales denote either pulmonary catarrh, or bronchitis, affecting the larger bronchial tubes; which may be primary affections or complications of other diseases, viz., pneumonitis, tubercle, emphysema, etc. The coexistence of other morbid conditions is to be determined by the associated signs, in conjunction with symptoms. Occurring in connection with other diseases which are oftener limited to one side of the chest than primary catarrh or bronchitis, it will be confined to the side affected; and hence, when present on both sides, it is presumptive evidence that the bronchial affection is primary.

The sonorous and sibilant rales are often heard in combination; that is, the sonorous existing at some parts of the chest, and the sibilant at other parts at the same moment; or the two alternating at irregular intervals with successive acts of respiration in the same situation; or, again, both appreciable at the same instant, sometimes commingled together, and sometimes succeeding each other at different periods of a single respiration. When combined, it is evidence that the bronchial affection is seated both in the larger and smaller tubes. The sonorous, like the sibilant rale, is especially marked in cases of pulmonary catarrh or bronchitis occurring in connection with emphysema. It is in such cases that the sounds are sometimes so intense as to be heard at a distance. On applying the ear to the chest in the early part of these affections, or during a paroxysm of asthma, frequently a great variety of musical tones are heard, which, if auscultation be continued, are found to undergo constant mutations. They are sometimes continuous, not only during the two acts of respiration, but uninterrupted by the intervals between successive respirations, the contraction of the lung prolonging the sounds with expiration after the visible expiratory movements have ceased. In the progress of catarrh and bronchitis they diminish, or cease entirely, becoming merged in the moist rales to be presently considered.

The discrimination of both species of the dry rales from other sounds emanating from the chest is attended with no difficulty. A mere description of their characters suffices for their recognition when heard for the first time. They are quite unlike any of the modifications of the natural respiratory sounds, and are distinguished by points not less striking from other rales. As diagnostic signs they are important, indicating, as has been stated, in the great majority of instances, the early stage of bronchial catarrh or inflammations, affections of frequent occurrence. As denoting these affections, their signification is almost positive; and if they are present extensively on both sides of the chest, together with the negative evidence afforded by the absence of the signs of other diseases, the diagnosis is complete. Pulmonary catarrh and bronchitis, however, not unfrequently occur as complications of other diseases. Under these circumstances the former are oftener confined to one side of the chest, or still more circumscribed, while the reverse is the rule when these affections are idiopathic or primary. But the fact of their existence as complications is to be established by the concomitant signs and symptoms of the co-existing diseases.

3. *Mucous rales.*—The mucous rales are the moist bubbling sounds produced in any portion of the bronchial tree except the minute branches, the sounds in the latter situation constituting the sub-crepitant rale. The term mucous is here used in a generic sense to comprehend sounds, essentially similar in character, which are due to the presence of any liquid in the subdivisions of the bronchi. Mucus is the kind of liquid oftenest present; but other kinds are pus, blood, softened

tubercle, and serum. Whenever either of these fluids is contained within the bronchial tubes, the currents of air with the respiratory acts, together with agitation of the liquid, cause explosive bubbles, which give rise to sounds more or less intense. These sounds have a bubbling character, which is distinctive. In contrast with the rales already considered, they afford intrinsic evidence of the presence of a liquid; in other words, the ear appreciates at once, the fact that they are moist rales. Differences in the quality of the liquid, as respects viscidity, etc., doubtless affect somewhat the character of the sound. The variations, however, due to this source are not sufficiently defined to serve as the basis of well-marked distinctions. So far as the audible characters are concerned, the only inference to be drawn is, that liquid of some kind, in greater or less abundance, is contained in the bronchial tubes. Generally the kind of liquid is determined demonstratively by an examination of the matter of expectoration. The mucous rales may be imitated by blowing through a tube introduced into any liquid.

The character of the sounds indicates the size of the tubes in which they are produced. In the larger tubes the bubbles appear to be of greater volume: perhaps, the difference is in part owing to the space in which the explosions occur. At all events, the bubbling sounds differ perceptibly according to the dimensions of the bronchial subdivisions in which they are produced. This has been shown by experiments in which, after death, sounds differing according to the size of the tubes are produced by injecting fluids into different sections of the bronchiæ, and afterward introducing currents of air by inflation.[1] These differences are expressed by the adjectives coarse and fine; and the different degrees of coarseness and fineness are expressed approximately by words of quantity, such as *very*, *considerable*, *moderate*, etc. These expressions are sufficiently precise for practical purposes. The coarsest mucous rales, then, are produced in the largest bronchial tubes; they lose this quality gradually in the subdivisions of these tubes, until in the smaller ramifications before reaching the minute branches, they assume the quality of fineness; and this fineness merges into the still finer sub-crepitant rale. It would be difficult to determine the particular locality at which the sounds cease to be coarse and become fine; and it is equally difficult to draw the line of demarcation between the two classes of sounds with exactitude; but such precision is of no consequence in diagnosis.

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[1] Barth and Roger.

The mucous rales resemble the dry rales in variableness. They are liable to appear now here and now there, shifting their seat from one part of the chest to another part; occurring not with each respiration, but intermittingly in the same locality, and are often removed for a time by an act of expectoration. The bubbling sounds heard at the same moment in a single spot may not be uniform. Bubbles of unequal volume appear to be commingled together. The sounds may be heard with inspiration or with expiration, or with both acts. Finally, they may exist on both sides of the chest, or on one side only, or in a circumscribed space on one or both sides.

In the great majority of cases mucous rales constitute the physical sign of pulmonary catarrh or bronchitis advanced to the second stage, or the stage of mucous secretion. The rales, other things being equal, will be diffused over the chest, and intense in proportion to the extent to which the irritation or inflammation pervades the bronchial mucous membrane, and the abundance of the mucus secreted in consequence. If fine and coarse rales are intermingled, which is not infrequently the case, it is evidence that the affection of the membrane is not confined to the larger tubes, but extends to those of smaller size. In the progress of the affections just mentioned, the dry rales may gradually disappear and give place to the moist; but it is not infrequently the case that the former do not entirely cease, and the different varieties of the dry and moist rales are combined in various and constantly varying proportions.

In view of the fact that bronchitis and pulmonary catarrh affect the bronchial tubes on both sides of the chest equally, if mucous rales are found on the two sides, and especially toward the lower part of the chest behind, the evidence of one or the other of these affections is almost conclusive. The rales are most apt to be present, or to be more marked in the situation just mentioned, viz., at the lower part of the chest behind, on account of the larger number of bronchial subdivisions, the greater amount of inflammation in this situation, and also because, from their position, the removal of their liquid contents is effected less easily than from the tubes at the superior portion of the lungs.

If, on the other hand, the rales are confined to one side of the chest, they denote a bronchial affection not primitive, but secondary, occurring, for example, as a complication of pneumonitis. Or they may be produced by the presence of liquid in the bronchial tubes irrespective of any affection of the tubes themselves. Thus, pus in this situation may be derived from the pleural cavity, the liver, or an abscess formed within the pulmonary parenchyma; the tubes may contain blood in cases of hæmoptysis, or pulmonary apoplexy, or serum in bronchorrhœa and œdema. In all such instances the nature of the disease to which the mucous rales are incident, is to be determined by other associated signs and by symptoms.

If the rales are confined to a circumscribed space at the summit of the chest; or, even if they are more marked in this situation, and especially if they are either present on one side only, or persistingly more marked on one side than on the other, they constitute a sign significant of phthisis, like the dry rales, particularly the sibilant, under similar conditions, and for the same reason, viz., they indicate a bronchitis confined to a small section of the bronchial tubes. Thus restricted, the disease is never primitive, but dependent on a prior local affection, which affection, when the circumscribed bronchitis is situated at the summit of the chest, in the vast majority of cases, is tuberculosis. Mucous rales are apt to attend tuberculous disease in all stages of its progress, being produced not alone by bronchitis occurring as a complication, but by the presence of liquid derived from tuberculous excavations. Moreover, the bubbling and agitation of the liquid contents of small cavities occasion rales which cannot be distinguished from those produced within the large bronchial tubes. In general, mucous rales do not accompany, in a marked degree, tuberculous disease prior to the stage of softening and excavation.

4. *Sub-crepitant rale.*—By some writers, all the moist bronchial rales are embraced under this title;[1] and, on the other hand, the sub-crepitant might with propriety be regarded as a variety of mucous rale. A reason for making it a separate physical sign is, that approximating in certain of its characters to the rale produced within the air-vesicles, it is important to be discriminated from the latter. The name expresses the resemblance just referred to. The sub-crepitant rale forms an intermediate link between the mucous and the crepitant rales. It is distinguished from the mucous rales by its greater degree of fineness. It is produced in the minute bronchial ramifications, but not in the capillary bronchi. Its locality accounts for its being finer, that is, for the bubbling being smaller than other bronchial rales. The bubbling character of sound is however preserved; the sensation conveys the idea of the presence of a liquid in tubes of small dimensions. The bubbling sound is generally unequal; in

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[1] Barth and Roger.

other words, it seems to be made up of bubbles uniformly small, but of different volumes. This character is due to the fact that the subdivisions in which the rale is produced, although minute, are not of the same calibre. It is heard in inspiration and expiration, with either or with both. It may continue during the whole duration of the inspiratory or the expiratory sound, or be heard only during a small portion of one or both of the respiratory acts.

In its persistence it presents somewhat of the irregularity and want of uniformity which characterize the mucous rales, but its variableness is less marked. These few points are important to be borne in mind with reference to its distinctive characters as contrasted more particularly with the crepitant rale.

The sub-crepitant rale attends those affections in which a liquid is present in the minute bronchial branches. The liquid is different in different forms of disease, presenting the same varieties as in the case of the mucous rales, viz., mucus, pus, serum, softened tubercle, blood. These different liquids are present in the minute bronchial branches, in capillary bronchitis, pneumonitis, œdema of the lungs, phthisis, hæmoptysis, and pulmonary apoplexy. The sub-crepitant rale, therefore, is liable to occur in each of these diseases. So far as the audible characters pertaining to the rale are concerned, it is impossible to determine thereby the nature of the liquid giving rise to the bubbling sound. This assertion is in opposition to the views of Fournet, who describes a distinct rale for each of the several affections just named. In this he is not followed by other auscultators, who regard the rale as essentially identical in all, although by no means uniform in every respect, even in different cases, and at different periods of the same affection. The discrimination of the different affections characterized by the presence of this sign, is to be based, not on intrinsic differences in the characters pertaining to sound, but on other circumstances to which I shall briefly allude.

In capillary bronchitis the membrane lining the minute bronchial branches is the seat of inflammation. The inflammation may be limited to this section of the bronchial tubes, or it may affect, at the same time, the larger subdivisions. The sub-crepitant rale in this disease is due to the presence of mucus. It succeeds, and may be more or less intermingled with, the sibilant rale, and if the affection be not confined to the minute branches, also with the sonorous and mucous rales. Capillary, as well as ordinary bronchitis, affecting, when primary, both sides of the chest, the rale will be present on the two sides, and especially at the base of the chest behind. This is an important diagnostic point, inasmuch as the other affections to which the rale is incident, are usually confined to one side of the chest. A sub-crepitant rale at the base behind on both sides is almost conclusive evidence of capillary bronchitis, as distinguished from pneumonitis, in which the crepitant rale, in the great majority of cases, is present on one side only. But other evidence derived from physical exploration may be brought to bear on the differential diagnosis, exclusive of the characters distinguishing the crepitant from the sub-crepitant rale. In capillary bronchitis the percussion-resonance continues clear, while in pneumonitis it becomes dull. In the former the sub-crepitant rale continues, and is replaced by the vesicular murmur; in the latter it soon diminishes or ceases entirely, and generally gives place to the bronchial respiration. These circumstances will aid in arriving at a positive conclusion in instances in which, judging from the intrinsic characters pertaining to the rale, there might be room for doubt.

The sub-crepitant, however, as well as the crepitant rale belongs to the natural history of pneumonitis. It occurs in a certain proportion of cases during the stage of resolution, having been preceded by the crepitant rale, and the physical signs of solidification of lung. With the latter signs it is moreover associated. Under these circumstances it constitutes the *rhoncus crepitans redux*, or returning crepitant rale of Laennec.

In pulmonary œdema the sub-crepitant rale is due to the presence of serous fluid within the minute bronchial branches. Occurring in connection with this rather rare form of disease, it is usually limited to one side of the chest; is present on the posterior surface; accompanied with more or less dulness on percussion, and found in connection with the ulterior morbid conditions upon which the production of œdema depends, viz., disease of heart, more especially blood changes leading to stasis in the pulmonary capillaries (as in fevers), or favoring serous transudation. These circumstances, together with the absence of more or less of the physical signs of pneumonitis, in addition to the characters distinguishing the sub-crepitant and crepitant rales, enable us to exclude the latter affection.

In phthisis a sub-crepitant rale may be due to circumscribed capillary bronchitis in the vicinity of the tuberculous deposit, or it may proceed from the presence of liquefied tubercle in the minute tubes. In the first instance, it may occur early in the disease; in the latter, not until a later period, after softening has taken place. In either case its significance depends on conditions similar to those which render a sibilant or a mucous rale a sign of tuberculosis, viz., its situation at the summit of the chest, within a circumscribed space. With these conditions, a sub-crepitant rale is strongly indicative of the existence of phthisis.

In hæmoptysis and pulmonary apoplexy the presence of liquid blood in the minute bronchial branches, may give rise to a sub-crepitant rale. It is, however, by no means a sign constantly attending these affections. It is observed in but a certain proportion of cases, and is of small value in their diagnosis. Blood escaping from the pulmonary vessels either passes into the larger tubes, and is expectorated; or it coagulates, constituting apoplectic extravasation; both results doing away with the physical conditions necessary to develope the rale under consideration.

The sub-crepitant rale is an important physical sign. From the mucous rales it is distinguished chiefly by the sensation which it conveys of a finer bubbling sound. The characters which will be presently found to mark the distinction from the crepitant rale are, the sense of a liquid, inequality in volume of the bubbles, its presence sometimes with expiration, as well as inspiration. In some instances the approximation is so close to the crepitant rale that, it must be confessed, judged by intrinsic characters, it would not be easy practically always to make the distinction.

5. *Crepitant rale.*—The crepitant, also called the crepitating and crepitous rale, is distinguished from the rales already considered by its origin. It is a vesicular rale; but it is not produced exclusively within the vesicles. The anatomical relations of the air-cells and the capillary bronchi are such that they can hardly be isolated from each other; and, in fact, the physical conditions giving rise to the crepitant rale pertain equally to both.

The character of the sound is well expressed by the term crepitating. Laennec compared it to the noise produced by salt in a heated vessel. Barth and Roger liken it to the crackling of a moistened sponge, expanding close to the ear after being forcibly compressed. Dr. Williams has suggested an excellent imitation, viz., the sound caused by rubbing a lock of hair between the thumb and finger close to the ear. Other illustrations might be cited, but these are sufficient, and the one last mentioned is available at any moment. Opportunities for studying the rale itself are sufficiently abundant everywhere, and after a description of its characters, with the comparisons just mentioned, the student will have no difficulty in recognizing it the first time it is presented to his notice. As already stated, it bears a resemblance to the sub-crepitant rale. The two rales approximate in their audible characters, but usually they are readily distinguished by their intrinsic differences alone, and always with the aid of collateral circumstances. The peculiar traits by which the crepitant rale is characterized may be best exhibited by contrasting it with the sub-crepitant rale. The sound in the crepitant rale is a true crepitation, while in the sub-crepitant rale it is a fine bubbling, approaching to a crepitating character. With the common idea that in both instances the sound is caused by minute bubbles, it is usual to say that the crepitant is a finer rale than the sub-crepitant. It will presently be seen, however, that agreeably to the most rational explanation of the crepitant rale, it is not a bubbling sound. The crepitant rale, in fact, so far as the sound is concerned, belongs among the dry rales. It does not convey to the ear the sensation of the presence of a liquid. Laennec regarded it otherwise, and in conformity with the prevalent opinion respecting its mode of production, it is included in the division of moist rales. Laennec, however, undoubtedly confounded the crepitant and sub-crepitant rales, the points of distinction between the two having been indicated since his time. He designated the crepitant as the *moist* crepitant, but in describing its characters in connection with the diagnosis of pneumonia, he says, it "seems hardly to possess the character of humidity." Auscultators at the present day who attribute the sound to bubbles, nevertheless consider dryness as one of its distinctive features. The sound appears to be made up of a large number of minute crepitations, in all respects equal. In this point of view it differs from the sub-crepitant rale, which is composed of unequal sounds, owing to the bubbles taking place in tubes differing considerably in calibre. The equality of the multitude of minute sounds which combine to form the crepitant rale is due to the fact that the spaces in which they are produced are more uniform in size. The crepitating sounds are rapidly evolved, occurring, as it were, in puffs, resembling the noise produced by ignition of a small train of gunpowder, to which it has been aptly compared. The sub-crepitant, as well as the mucous rales, take place more slowly.

In addition to the foregoing points which pertain to the audible characters, there are others not less distinctive. The crepitant rale is not variable. It continues constantly for a certain period, not changing with different respirations, save in intensity, and this is usually proportionate to the force with which respiration is performed. It is sometimes developed by forced breathing when it is not otherwise appreciable. It is not suspended by coughing and expectoration. On the contrary, after an act of coughing, the respiratory movements immediately succeeding being more forcible, it becomes more intense. Finally it is heard with the inspiratory act exclusively. This is certainly the rule, and the exceptions, if they exist, are extremely rare. This last point, to which attention was first called by Dance, is eminently distinctive; the sub-crepitant rale, as well as the mucous rales, being present frequently in the expiratory, as well as the inspiratory act. This point, as will be seen presently, has an important bearing on the explanation of the mechanism by which the rale is produced.[1]

Laennec regarded the crepitant rale as almost pathognomonic of the early stage of pneumonitis. At the present time, its distinctive characters having been more clearly defined, it is even more significant as a diagnostic sign than heretofore. A true crepitant rale is very rarely observed except in the early stage of pneumonitis. Moreover, it is very rarely the case that it is absent during the career of that disease. The opinion of Skoda is in opposition to the latter statement. He declares that not only has he failed to find it present, but he has not often observed it. This is one of the extraordinary assertions enunciated by that writer. It is at variance with the observations of others, whose opportunities for studying this disease have been quite as extensive. For example, Grisolle, who has contributed the results of the numerical investigation of a large number of cases of pneumonitis, affirms that this sign was wanting in only four instances. M. Aran failed to discover it in only one of fifty cases. That it is not invariably present is undoubtedly true, but the experience of most auscultators is united on the fact of its existence being the rule in the lobar form of pneumonitis. In the lobular form of children the rule does not hold good. Not only, therefore, is it, as originally claimed by the founder of auscultation, almost pathognomonic when present, but its constancy makes it reliable as a diagnostic criterion.

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[1] A pleural friction-sound sometimes bears a very close resemblance to the crepitant rale, so that, judged by the audible characters alone, the former may be mistaken for the latter. This I state from experience. Barth and Roger state this liability to error, as follows: "Il est un autre bruit qui pourrait facilement induire en erreur une oreille peu exercée: le *frottement pleurétique* est parfois constitué par une série de petits craquements successifs, par une espèce de crepitation inégale, que le rapproche du véritable rhonchus crépitant. C'est sans doute cette variété de bruit qui a fait dire qu'il existait un *râle crépitant dans la pleurésie.*" P. 149.

It is usually discovered shortly after the attack of pneumonia in adults; but this rule is less uniform than its existence at some period of the disease. In most cases of frank pneumonitis, it is strongly marked prior to the physical evidences of solidification, viz., notable dulness on percussion and the bronchial respiration. In quantity and intensity, however, different cases differ. When abundant, it is heard during nearly the whole of the inspiratory act. If produced throughout an entire lobe, or within the cells at the exterior portion of the lung, it is loudly developed, and seems very near the ear; but when confined to a central situation, healthy lung intervening between the affected part and the thoracic walls, it is comparatively feeble and distant. In these respects every shade of diversity is presented in a sufficiently large number of cases. Frequently it continues more or less during the stage of solidification, and sometimes it does not appear prior to this stage. It is then associated generally with the bronchial respiration; and, under these circumstances, it is observed only at the end of the inspiratory sound. Occasionally it is developed by a forced inspiration, when it is not appreciable with ordinary breathing. The situation in which it is found in the majority of the cases of pneumonia, is the posterior surface of the chest, especially below the scapula, the disease, as a general rule, affecting the inferior lobe. It is oftener found on the right than the left side, because the lower lobe of the right lung is more frequently attacked. Its existence on one side of the chest is an important diagnostic circumstance; for pneumonitis, in the vast majority of cases, is confined to one side. On the contrary, capillary bronchitis as uniformly affecting both sides equally, the sub-crepitant rale is heard on both sides. This distinction, aside from the distinctive characters pertaining to the crepitant and the sub-crepitant rales respectively, suffices, in general, for a differential diagnosis. A rale, concerning which we may have some doubt whether to regard it as a crepitant or sub-crepitant, if it be present on the posterior surface of the chest on both sides is, in all probability, a sub-crepitant; but if confined to the posterior surface on one side, the chances are equally great, that it is a crepitant rale.

Pneumonitis may be complicated with general bronchitis. This coincidence is not frequent, but of occasional occurrence. The vesicular rale and the bronchial rales, will then be likely to be variously combined. Capillary bronchitis and pneumonitis are sometimes associated. In a case of this description which recently came under my observation, the fact of the concurrence of the two diseases having been demonstrated after death, the sub-crepitant rale existed on both sides, but on one side the sub-crepitant and crepitant rales were distinctly appreciable during the same inspiration, the former during the first part, and the latter at the close of the act.

The returning crepitant rale, *râle crepitant de retour*, described by Laennec as characterizing the resolution of pneumonitis, occurs in only a certain proportion of cases. It denotes the presence of liquid in the smaller bronchial branches, and is a sub-crepitant rale. This, in fact, with our present knowledge of the two rales, is a fair inference from the description by Laennec. The occurrence of the sub-crepitant rale at this stage of pneumonitis has already been mentioned.

In the vast majority of cases, the crepitant rale denotes pneumonitis. It is not, however, true that it never occurs in any other affection. It has been observed in œdema, and possibly in hæmoptysis. In these affections, the rale is generally a sub-crepitant, but the presence of serum, and perhaps of blood, in the air-cells, may give rise to a rale essentially similar to the true crepitant of pneumonitis. In hæmoptysis, the expectoration of blood settles the diagnosis. Moreover, in this case the rale will be found at the summit of the chest in front, and not on the posterior surface, as in the larger proportion of cases of pneumonitis, hæmoptysis being generally incident to tuberculous disease. The differential diagnosis of pneumonitis and œdema, is to be based on the associated circumstances which will usually suffice for discrimination without much difficulty. Œdema is comparatively rare. It occurs in certain pathological connections, and is unattended by the symptoms which usually accompany an attack of pneumonitis.

A crepitant rale, at the summit of the chest on one side in front, confined within a circumscribed space, is a significant sign of phthisis. Primitive pneumonitis, in the adult, as already stated, generally invades an entire lobe, and in the great majority of instances, an inferior lobe. When situated toward the apex of the lung, and extending over a small area, the pneumonitis is secondary, and the antecedent affection is probably tuberculosis, inflammation having been developed in the immediate vicinity of the tuberculous deposit. This rale, with the conditions just stated, becomes a sign of phthisis like the sibilant, the mucous, and the sub-crepitant rales, under similar circumstances.

The explanation of the mechanism by which the crepitant rale is produced, given by Laennec, and generally received at the present time, attributes it to the formation of minute bubbles within the vesicles, and terminal bronchial tubes. According to this theory the mechanism is precisely similar to that involved in the production of the mucous and sub-crepitant rales, the difference in the audible characters being supposed to be owing to the smaller size of the spaces in which the bubbling takes place. This explanation is unsatisfactory, in view of several facts pertaining to the characters distinctive of the crepitant rale. The absence of humidity, in other words, the dryness of the sound; the constancy of the rale during the period of its continuance, and especially its accompanying exclusively the act of inspiration, militate strongly against the doctrine commonly held. To meet these objections, Dr. Walshe suggested that the sound may be due to the sudden pressure exerted on exudation-matter between the vesicles, by the expansion of the lung. But the exudation in pneumonitis is within the air-cells, and, hence, in so far as the sound depends on this result of inflammation, it must be intra-vesicular. The most rational theory, and the one which meets best the objections to that of Laennec, was offered several years ago, by Dr. Carr, of Canandaigua, N. Y. Dr. Carr attributes the production of the sound to the abrupt separation of the walls of the cells, which had become adherent by means of the mucus, or the viscid exudation incident to the early stage of inflammation.[1] That this explanation accounts for the peculiar, dry, and crackling sound, as remarked by Dr. C., a simple experiment will serve to illustrate. If the thumb and finger be moistened with a little paste, or solution of gum arabic, and, while held near the ear, alternately pinched together, and separated, an imitation of the crepitant rale is produced more perfect even than rubbing a lock of hair, as proposed by Dr. Williams. A viscid exudation within the cells and minute bronchiæ belongs among the local phenomena of the disease; and as it is not readily removed by expectoration, but accumulates till the cells are filled, and the lung solidified, the constancy of the rale for a certain duration is intelligible. Its occurrence with inspiration only, is fully explained by this theory. The conditions for the production of the sound are only present after the lungs have collapsed with expiration, at the moment when the agglutinated walls of the vesicles are separated with the expansion of the lung by the inspiratory act. Adopting Dr. Carr's explanation, it would be expected, as observation shows it to be true, that the sound would be present in the early stage of pneumonitis, the air in this stage still entering the vesicles, and subsequently cease, nearly or entirely, in proportion to the extent and completeness of the subsequent solidification. The fact that when solidification has taken place, a certain number of cells are not filled with the morbid exudation, and remain in the condition which characterizes all the cells in the early stage, explains the persistence of the rale in some cases during the second stage of pneumonitis, and its being developed, under these circumstances, by forced inspirations, and especially at the end of the inspiratory act. The theory of Dr. Carr is also equally applicable to the cases of œdema and hæmoptysis, in which the crepitant rale is observed. In these affections the vesicles contain a glutinous liquid, although in a less marked degree than in pneumonitis; and we can readily understand that the necessary physical conditions are present sometimes, but not constantly, on account of the greater facility with which the liquid escapes from the cells into the bronchial tubes, giving rise to the bubbling rales—the sub-crepitant and mucous.

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[1] New explanation of the crepitant rhonchus of pneumonia, by E. A. Carr, M.D.—American Journal of Medical Sciences, October, 1842.

In view of the pathognomonic character of the crepitant rale, and the uniformity with which it attends the early stage of pneumonitis, it was justly considered by Laennec to be one of the most important of the physical signs. In its diagnostic value as an isolated sign it is entitled to the first rank among the phenomena furnished by auscultation.

6. *Cavernous Rale, or Gurgling.*—The entrance of air into a cavity partially filled with liquid, gives rise to a sound resembling a mucous rale produced within the larger of the bronchial tubes, from which it cannot always be distinguished; and hence, according to some writers, it is needless to describe a cavernous rale as an independent physical sign. In some instances, however, the sound is sufficiently distinctive to indicate very clearly the existence of a cavity, and therefore it is entitled to a separate place among the phenomena of auscultation.

A cavernous rale is a moist sound, conveying very distinctly the idea of a liquid. It is produced partly by bubbles, and in part by the agitation of the mass of liquid. The bubbles, in cases in which the characteristic sound is well-marked, appear to be larger in size than the coarsest mucous rale, and, at the same time, fewer in number.

The liquid thrown into agitation by the impulse of the air, causes a sound, of which the best description is embraced in the term gurgling. It may be compared to the sudden commotion which occurs from time to time, when a liquid is brought nearly to the point of ebullition. The latter is an occasional variety of the cavernous rale, and is presented in the most marked degree when the communication of the cavity with a bronchial tube is sufficiently large for a column of air of considerable size to enter with force, other favorable physical conditions also coexisting. The movements of the lung, irrespective of the entrance of air into the cavity, it is probable may suffice to produce a gurgling sound, but less in degree. The impulse of the heart sometimes causes sufficient agitation of the liquid to give rise to a rale, which is determined by observing that it continues when respiration is momentarily suspended, and is synchronous with the pulse. This curious fact has been repeatedly noticed when the cavity was seated in the left lung, but Dr. Stokes has observed it even on the posterior surface of the right side of the chest. The bubbling and gurgling sounds may take place with inspiration and expiration, conjointly or singly, and when with either separately oftener with the former act. The intensity of sound is sometimes so great, that it is heard at a distance from the patient. The reverberation within the space, above the level of the liquid, occasionally gives rise to a metallic or amphoric tone.

The cavernous rale usually exists over a circumscribed space, on one side of the chest; and inasmuch as excavations are in the vast majority of cases of tuberculous origin, its situation in forty-nine of fifty cases, is at the summit of the chest. The physical conditions necessary for the development of the rale, when the cavity is partially filled, occasion the cavernous respiration when the cavity is empty. These two signs will therefore be found in certain cases to occur in alternation, and will serve mutually to confirm each other.

A cavernous rale, depending as it does on several circumstances, in addition to the existence of a cavity, is by no means constant, and, in fact, is only occasionally discoverable. The cavity must contain a certain amount of liquid, neither being empty, on the one hand, nor on the other hand, completely filled. The communication with the bronchial tubes must be below the level of the liquid. This communication, and the bronchial tubes themselves, must not be obstructed by morbid products. The concurrence of these conditions can only be expected to obtain now and then, so that we may auscultate for this sign repeatedly, in cases in which a cavity or cavities exist, without success. The value of the sign in diagnosis, therefore, is altogether positive; negatively, it is of little or no value: that is, we are not authorized to infer the non-existence of a cavity from the absence of the sign.

Other things being equal, the size of the bubbles and the loudness of the gurgling will be proportionate to the magnitude of the cavity. When the rale closely resembles the mucous, but retains the cavernous characters sufficiently to be distinguished from the latter, it has been called[1] *cavernulous*, and supposed to indicate the existence of small excavations. This distinction, however, is clinically unimportant.

As has been stated, a well-marked cavernous rale at the summit of the chest denotes almost with certainty, an excavation proceeding from tuberculous disease. But the rale may be present in cases in which cavities are otherwise formed, viz., from circumscribed gangrene, abscess, and pouch-like dilatation of the bronchiæ. It may also exist in cases of perforation of the lung, with accumulation of liquid in the pleural sac, *i. e.* in pneumo-hydrothorax. The diagnosis of each of these affections must, however, be based mainly on other signs. The infrequency with which this rale is discovered, the difficulty in many instances of discriminating between it and coarse mucous rales (the two being, moreover, frequently commingled), together with the fact, that it generally occurs at a period of disease, and under circumstances when the diagnosis is sufficiently easy, and has probably been already made, render it a sign of minor practical consequence.

7. *Indeterminate Rales.*—Under this head may be embraced a variety of adventitious sounds, not clearly referable to either of the foregoing divisions, and of which the situations, as well as the manner of production, are matters of doubt. Notwithstanding this uncertainty as respects their locality and explanation, some of these sounds are by no means without value as physical signs, observation having established their pathological relations.

(1.) Laennec described a distinct sound which he designated by the somewhat contradictory phrase, "Dry crepitant rale with large bubbles" (*rale crepitant sec à grosses bulles*). This sound, according to Laennec, "conveys the impression as of air entering and distending lungs which had been dried, and of which the cells had been very excessively dilated, and resembles the sound produced by blowing into a dried bladder.[1] He regarded the sound thus described as characteristic of emphysema of the lungs. Most auscultators, since the time of Laennec, have failed to discover a rale with well marked characters of the kind just stated; and multiplied observations in cases of emphysema do not establish its connection with any such sign. It is probable that in assuming this rale, Laennec was influenced by preconceived notions. Having established a moist crepitant rale, he was led theoretically to assume the existence here, as in other instances, of a dry crepitant rale. At all events, if a rale, such as Laennec described, exists, in view of the difficulty of appreciating it and its indefinite signification, it is practically unavailable in diagnosis.

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[1] This title was first applied by M. Hirtz, of Strasbourg.

Pulmonary crumpling.—Under the title of *froissement pulmonaire*, rendered as above, Fournet embraced a variety of sounds as bearing to each other close resemblance, save that, according to this observer, an impression is conveyed to the mind of the auscultator of the "pulmonary tissue forcibly struggling against some impediment to its expansion." One variety he compares to the new leather friction-sound (*bruit de cuir neuf*) heard in pericarditis; another is a plaintive mewing-sound with various modulations; another is like the sound produced by blowing upon tissue-paper. These sounds, differing so much in their audible characters, admit of being classed together only as indeterminate rales. The bond of union stated by Fournet must be regarded as fanciful. The sound resembling the crumpling of tissue-paper, and that of new leather, may be veritable pleural friction-sounds. The various mewing-sounds are probably sonorous bronchial rales. Fournet endeavors to establish points of distinction between them collectively and other rales, but the chief characteristic is that by which they are placed in the same category, viz., the impression conveyed to the ear of a struggle against an obstacle. Such impressions are so apt to originate within the mind that they are to be trusted but to a limited extent, in forming opinions respecting the explanation of auscultatory signs.

It is chiefly with reference to the diagnosis of tuberculous disease that the sounds regarded by Fournet as dependent on pulmonary crumpling are of practical importance. And their diagnostic importance, in this relation, is irrespective of the question whether they are properly varieties of the same sign, and of any hypothesis as to their mode of production. Fournet states, that he has observed a *bruit de froissement* in the proportion of about one-eighth of persons affected with phthisis. Occurring at the summit of the chest, frequently, if not generally limited to one side, and confined within circumscribed limits, a rale resembling either of the sounds above described, belongs among the numerous and varied physical signs which, from their situation and limitation, taken in connection with symptoms, point to the existence of a tuberculous deposit. According to Fournet, these sounds are observed in the early stage of phthisis, and the acute form of the disease, or tuberculous infiltration, is especially favorable for their development.

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[1] Op. cit.

Pulmonary crackling.—A crackling sound, presenting certain varieties (*râles de craquement*), like the preceding, has been particularly described by Fournet, and is recognized as a distinctive auscultatory sign by most writers on the subject of physical exploration. The varieties of this sound are arranged in two classes, viz., *dry crackling* and *moist crackling.* Like the so-called crumpling sounds, they belong among the physical signs of phthisis, and are entitled to considerable weight in the diagnosis of that disease. Their diagnostic significance, like that of several other signs of tubercle already mentioned, depends on their being observed at the summit of the chest within a circumscribed space.

Dry crepitation bears a close resemblance to the crepitant rale. Like the latter, it appears to be made up of distinct crepitations, but much fewer in number, frequently, according to Fournet, not exceeding two or three. Like the crepitant rale, it occurs almost exclusively with inspiration. The mechanism of the sound is generally considered doubtful. The most rational supposition, as it seems to me, is, that it is produced in the same way as the crepitant rale, viz., by the abrupt separation of the walls of a few cells which become adherent, when the lungs are collapsed, in consequence of the presence of a small quantity of glutinous exudation.[1] The sound is occasionally observed during a few respirations in the healthy chest. In the twenty-four examinations to which reference was made under the head of Auscultation in Health, I met with it in two instances, in both of transient duration. It is a sign of rather frequent occurrence in the early stage of phthisis; and, under these circumstances, is usually constant during the period of its persistence. Of fifty-five cases, in which it was observed by Fournet, its constancy was noted in all but nine instances. The crackling appears removed from the surface of the lung, not near the ear,—a point which serves to distinguish it from a pleural friction-sound.

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[1] This explanation accords with the description of the character of the sound by Fournet: "Il consiste dans une sensation toute particulière de *rupture*," etc.

Moist crackling, according to Fournet, is developed at a later stage of the disease. The dry sometimes merges into the moist rale. Moist crackling appears to me to be neither more nor less than a sub-crepitant rale. As the title imports, it differs from dry crackling in its conveying the sensation of the presence of a liquid. It is not confined to inspiration, but occurs also in expiration. It is supposed by Fournet to indicate the transition of crude tubercle to softening, dry crackling pertaining to the period of crudity. It is probably due to the presence of fluid in the smaller branches of the bronchial tubes, and this fluid may be softened tuberculous matter, or mucous secretion from bronchitis affecting the smaller tubes within a limited area. The occurrence of the two kinds of crackling in regular succession, and the uniform relation of each to a different stage of tuberculous disease, are theoretical conclusions which observation has not conclusively established.

The foregoing are the adventitious sounds included within the denomination of rales. The subjoined table contains a recapitulation of the distinctive characters, and diagnostic indications pertaining to them respectively.

Table Exhibiting the Distinctive Characters and Diagnostic Indications of the Different Rales.

SIBILANT.	SONOROUS.
Dry sound, high in pitch; whistling, hissing, or clicking; sometimes musical.	Dry sound, grave in tone. Oftener musical than the sibilant; louder and stronger.
Variable in continuance, intensity, intonation, and situation. Suspended by coughing.	Variable in continuance, intensity, intonation, and situation. Suspended by coughing.
Present with inspiration, or expiration, or both; oftener with inspiration.	Present with inspiration and expiration; oftener the latter, and with both.
If present on both sides, indicative of primitive bronchitis or catarrh affecting the smaller tubes, or of bronchial spasm.	If present on both sides, indicative of primitive bronchitis, or catarrh, or of bronchial spasm.
Confined to one side, indicative of catarrh or bronchitis complicating pneumonitis or pleurisy.	Confined to one side, indicative of secondary bronchitis, or catarrh.

Limited to a circumscribed space at the summit of the chest, indicative of tuberculosis. Often associated with the sonorous and mucous rales.	Limited to a circumscribed space at the summit, indicative of tuberculosis. Often associated with the sibilant and mucous rales.
Mucous.	**Sub-crepitant.**
Moist, bubbling sounds. Coarse or fine, in proportion to the size of the bronchial tubes in which they are produced. Variable in continuance, intensity, situation, and degree of coarseness. Suspended by expectoration.	Moist sound, giving impression of very small bubbles. Bubbles somewhat unequal. More regular and constant than mucous rales. Less likely to be suspended by expectoration.
Present with inspiration, or expiration, or both. Coarse and fine rales often combined. If present on both sides at the inferior posterior portion of chest, indicative of second stage of primitive bronchitis or catarrh; the coarseness or fineness denoting extent of bronchial tubes affected. Confined to one side indicative of secondary bronchitis, or the presence of pus, serum, or blood in bronchial tubes. Limited to a circumscribed space at the summit, or more marked in that situation, indicative of tuberculosis more or less advanced. May be associated with sibilant and sonorous rales.	Present with inspiration or expiration, or both. If present on both sides at posterior inferior part of chest, indicative of primitive capillary bronchitis. Occurs in pneumonitis, at period of resolution; also in œdema, and pulmonary apoplexy, or hæmoptysis. Limited to a circumscribed space at the summit of the chest, indicative of tuberculosis.
Crepitant.	**Cavernous.**
Dry, crepitating sound. Evolved with rapidity, in puffs. Constant, not variable. Not suspended by coughing. Present with inspiration exclusively. Very rarely existing on both sides. Almost pathognomonic of the early stage of pneumonitis; frequently continuing through the disease, or giving place to a sub-crepitant rale. Occurs occasionally in œdema, and hæmoptysis. Limited to a circumscribed space at the summit of the chest, indicative of tuberculosis.	A moist sound, conveying the impression of very large bubbles, and the agitation of a mass of liquid (gurgling), occasionally synchronous with the heart's impulse. Present with inspiration, or expiration, or both, especially with inspiration. Sometimes accompanied with metallic reverberation. Generally situated at the summit of the chest. Alternating or combined with cavernous respiration. Ceases and returns at irregular intervals. Indicative of tuberculous excavations; cavities following abscess, circumscribed gangrene, and pouch-like dilatation of bronchial tubes.

INDETERMINATE.

1. *Râle crépitant sec à grosses bulles.*
2. Pulmonary crumpling.
3. Pulmonary crackling.

ATTRITION OR PLEURAL FRICTION-SOUNDS.—With the act of inspiration the thoracic space is enlarged mainly by depression of the diaphragm, and the elevation of the ribs. The lung expanding to fill the augmented capacity of the chest, moves in a vertical direction downward, while the walls of the chest ascend; and hence results, of necessity, a certain degree of friction of the pleural surfaces, which is repeated with the reverse movements of expiration.

Normal pleural friction takes place silently, as shown by experiments on inferior animals, and auscultation of the healthy chest. This is undoubtedly owing to the highly polished and moistened condition of the membrane. When, however, the surfaces are rendered irregular and rough by morbid exudation or other causes, there exist the physical conditions for the production of adventitious sounds, to which are applied the titles attrition or friction sounds. The mechanism of their production is sufficiently intelligible; the points of inquiry which suggest themselves are, the diversity of the sounds thus produced; their distinctive characters and the means by which they are to be distinguished; the diseases to which they are incident, and the circumstances on which depends their diagnostic significance.

The intrinsic differences of friction-sounds are such that they may be divided into several varieties. These, however, do not individually sustain pathological and clinical relations, so distinct and important as to claim separate consideration. A delicate *grazing* is one variety, occurring when the opposing movements are not forcible, or the physical conditions are not the most favorable for the production of sound. Another variety is a more distinct *rubbing*, chiefly denoting greater force of attrition. A greater degree of harshness of sound, dependent on greater roughness of the pleural surfaces, constitutes the variety called *rasping* or *grating*. A *creaking*, like new leather, is still another variety. These diversities of sound are due to differences which are in a certain sense accidental, and may be presented in different cases of the same affection, without furnishing any special indications as respects either the nature or degree of the disease. The grazing and rubbing sounds, which are the varieties ordinarily presented, may be exactly imitated by placing the palm of the left hand over the ear, with firm pressure, and moving slowly over the dorsal surface, the pulpy portion of a finger of the right hand.

A friction-sound may accompany both respiratory acts, or the act of inspiration alone. It is frequently heard with both acts, but very rarely limited to the act of expiration. When it accompanies both acts, it is more distinct with inspiration. It is seldom continuous during the whole of the inspiratory or expiratory act, but it occupies a portion only of its duration. Ordinarily, it is either a single sound of brief duration, or there occurs a series of sounds succeeding each other with more or less rapidity, resembling in this particular, interrupted or jerking respiration. Occurring in this manner it sometimes bears a very close resemblance to the crepitant rale, and may be mistaken for it. In some instances it continues uninterrupted through the act of inspiration, and may even be prolonged through the expiratory act, giving rise to a constant rumbling sound. In the great majority of cases, the sound is manifestly dry; but it may suggest the idea of moisture. This occurs when false membranes, situated on the pleural surfaces, become infiltrated with serum. Under these circumstances a sound may be produced, which Walshe characterizes as *squashy*. The intensity is variable. It may be so slight as to be but just appreciable, or it may be so loud as to be heard at a distance. An instance has fallen under my knowledge in which it was so intense as to be a source of annoyance to the patient, during convalescence from pleurisy. Between these extremes there is every degree of intensity. It is usually confined to a small space, but it may be more or less diffused, and occasionally is heard over the entire chest. In the latter case, it may be produced within a limited space, but its intensity causes it to be appreciable at a greater or less distance from its source. The situations where it is heard are usually the middle and lower portions of the chest, oftener laterally, or posteriorly. As exceptions to the general rule, it is sometimes heard at the summit, and thus situated, it has a special diagnostic significance, which will be presently mentioned. The sound always appears to be superficial, not emanating from beneath the superficies of the lung. This is a distinguishing feature. So superficial does it sometimes appear, that it seems to the auscultator to be produced upon the integument, and he is led by the apparent nearness of the sound, to suspect that a portion of the dress comes in contact with the ear or stethoscope. In some instances, a friction-sound is heard with each successive respiration, but oftener it is variable in this respect, accompanying some respirations, but being absent in others. It is sometimes appreciable only with forced respiration, and, on the other hand, it has been observed to be strongest when the breathing was tranquil. The sound has been observed to be increased when firm pressure is made with the stethoscope. It is also variable in duration. It may be transient, or it may continue in a greater or less period. In a case reported by Andral, it lasted for three months. It is observed in some instances to shift its seat, being at one time heard at a certain point, and at another time in a different situation, and these changes may take place repeatedly. Intermittency is another point of variability. It may be present, disappear, and again reappear, and these alternations may occur more than once in the progress of the same disease. Finally, if a friction-sound be strong, and especially if it be rough, it is perceptible to the touch, on placing the hand over the side, as well as to the sense of hearing; and in this way patients themselves become aware of a rubbing movement within the chest.

The distinctive characters of a pleural friction-sound, are such that its discrimination is not generally attended with difficulty. The sound itself conveys the idea of its being produced by friction. In addition to this, its dryness, its accompanying frequently both respiratory acts, and especially its superficial situation, serve to distinguish it from other adventitious sounds. As already stated, sometimes, when interrupted and limited to inspiration, it may be mistaken for a crepitant rale. The instances, however, in which this resemblance exists are rare, and the associated circumstances will generally prevent the error into which the auscultator might fall, were he to limit his attention solely to the character of the sound. In determining the existence of a friction-sound, in all cases we are aided by the coexistence of other signs, and of symptoms involved in the diagnosis of the diseases in which it is known to occur.

Dr. Stokes has called attention to the fact that a friction-sound may be due to the movements communicated to the adjacent portion of the pleura by the impulse of the heart. In this case, a friction-sound, in addition to that produced by respiration, will be found to be synchronous with the beating of the heart, or the pulse, and will continue when the respiratory movements are voluntarily suspended. The concurrence of a cardiac friction-sound, gives rise to the question whether it be of pleural or pericardial origin; and the settlement of this question clinically, must be attended with considerable difficulty. In general terms, if it have been preceded, or if it be accompanied by the signs and symptoms of pericarditis, it is in all probability pericardial; but if it be unattended by other evidences of an affection of the pericardium, and there are present the evidences of disease affecting the pleura, it may be suspected to have connection with the latter.

A pleural friction-sound was regarded by Laennec as a pathognomonic sign of interlobular emphysema. He did not, however, profess to have established this opinion on the evidence afforded by autopsical examinations, in cases in which the sound had been noted during life. Moreover, in the two instances given by him, in which he had observed this sign, the patients, if affected with interlobular emphysema, were also affected with pleurisy; and it is remarkable that its connection with the latter affection should not have presented itself to the reflections of the discoverer of auscultation. Subsequent observations have shown that in the interlobular, as well as the ordinary form of emphysema, and also in that variety in which air-vesicles are formed by the elevation of a portion of the pulmonary pleura, a friction-sound is an exception to the general rule. Dr. Walshe has noted the occurrence of the sign in a few instances of the variety last named. With exceptions so infrequent that they belong among the curiosities of clinical experience, a friction-sound is indicative of pleuritis. It is, however, by no means a sign constantly or even frequently present in that affection, and, indeed, is observed but in a small proportion of cases. It may occur in different stages of pleuritic inflammation: *first*, in the early stage, before the pleural surfaces are separated by liquid effusion; and *second*, at a later period, after absorption of the liquid has taken place, and the pleural surfaces are again brought into contact with each other. In the early period of the disease it is due to the presence of coagulable lymph, with which, to a greater or less extent, the surfaces of the pleura are covered; and according to Stokes, to abnormal dryness of the membrane, prior to the exudation of lymph. That abnormal dryness precedes, as a general rule, the exudation of lymph, is not certain, and that it is alone capable of giving rise to a friction-sound, may be doubted. But however this may be, it is certain either or both these physical conditions, so seldom give rise to a friction-sound in the first stage of pleuritis, that it scarcely possesses any importance as a sign to be relied upon in the diagnosis prior to the occurrence of effusion. The latter takes place so

[1] Vide Fournet, p. 210.

quickly after inflammation is established, that generally the pleural surfaces are already separated before patients come under observation. In hospital practice this is almost uniformly the case. Instances, however, are occasionally observed in which, notwithstanding a considerable, or even large accumulation of liquid in the pleural sac, a friction-sound is apparent. Dr. Stokes was the first to report a case of this description, and others have been subsequently reported. The explanation of the presence of the sign under these circumstances is, the lung having become attached, not closely, but by means of bridles of false membrane, to the thoracic walls, the pleural surfaces continue to come into contact over a greater or less extent of surface. This may obtain anteriorly, while the whole posterior surface of the lung is separated from the walls of the chest by a large quantity of fluid; and under these circumstances, the physical signs posteriorly show the presence of liquid, whilst, anteriorly, a friction-sound may be observed. Of the instances in which a friction-sound occurs in pleuritis, in by far the larger proportion it appears in a later stage after absorption. The pleural surfaces coming again into contact are roughened by semi-organized lymph. This is so disposed in different cases as to give rise to simple rubbing, to a rougher quality of sound, distinguished as grating, or rasping, to creaking, or, occasionally, to a sound conveying the impression of a liquid. These diversities in the audible characters do not furnish any indications as to the quantity of exudation, or the gravity of the affection, but simply denote differences pertaining to the disposition of the morbid matter, together with variations of dryness and firmness, etc.; and simple scarcely appreciable rubbing, may occur in cases in which the lymph is more abundant, and the disease more severe than in other cases in which the loudest, roughest sounds are discovered. The sounds are heard over the middle and lower portions of the chest in primary pleuritis, because, although the morbid condition may not be more marked here than at the summit of the chest, the respiratory opposing movements of ascent and descent are greater, especially in the male. The friction-sounds are not produced solely by the rubbing together of the pulmonic pleura and costal pleura, but probably oftener and with greater intensity, by the contact of the diaphragmatic pleura and costal pleura. The situation of the sign is sometimes, in fact, not over the lung, but over the diaphragm, viz., over the sixth and seventh cartilages.[1] But even after absorption a friction-sound is of rare occurrence in pleuritis. This is probably owing to the fact that adhesions of the pleural surfaces generally take place directly they are brought into contact. It is, however, not improbable that the sound is discoverable at some points oftener than is supposed, because, inasmuch as the diagnosis of pleuritis is sufficiently established, in the large majority of cases, long before the period arrives when the physical conditions are favorable for the production of this sign, it is not always sought for with care over all parts of the chest. Occurring subsequent to absorption in the progress of pleuritis, although not of importance as respects the diagnosis which it is to be presumed has been already made, it is yet of utility as evidence that the surface of the lungs is in contact with the walls of the chest. As stated by Fournet, in some cases this evidence is the more valuable, because, owing to the thickness of the layers of morbid deposit, percussion and the auscultation of the respiratory sound may be insufficient to determine the fact that the liquid is absorbed. At this period of the disease the sign is of good omen, denoting progress toward restoration.

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[1] Sibson's Medical Anatomy.

A friction-sound may accompany pleuritis developed as a complication, or an intercurrent affection. In pleuro-pneumonitis it is occasionally observed, being due here to the pleuritic complication, and produced in the same manner as when the pleuritis is primary. It is also one of the signs which, inferentially, point to tuberculous disease. Occurring in connection with tuberculosis, it may originate in two ways: *First,* The deposit of small isolated tubercles beneath the pulmonary pleura, may occasion an irregularity of the surface sufficient to give rise to a strongly marked sound of attrition. Fournet gives an instance of this kind; and a striking case was reported several years ago by Prof. Lawson.[1] *Second,* It is due to intercurrent pleuritis, confined to a circumscribed space, situated over the tuberculous deposits. Successive attacks of pleuritis, attended by the exudation of lymph, without liquid (dry pleurisy), and followed by adhesion of the pleural surfaces over the space affected, as is well-known, are so constant as almost to form a portion of the natural history of tuberculous disease of the lungs. A friction-sound, by no means uniformly, but occasionally, accompanies these attacks. Under these circumstances, the sign is confined to a small area at the summit of the chest, and is of the grazing or rubbing variety, never presenting the rougher qualities of sound with this character, and thus situated, *i. e.* at the summit of the chest, it is indicative of circumscribed pleuritis, which is incidental to tubercle, and therefore it becomes a physical sign of the latter disease. It is discoverable in only a small proportion of the cases of tuberculosis, and its absence is not entitled to any weight as negative evidence; but when present it is a sign of considerable diagnostic importance. Occurring in this connection it is of brief duration, usually continuing for a day or two only, being suspended by the adhesion of the surfaces over the space in which it was produced. And as this adhesion precludes the continuance of movements necessary for the production of the sound it is not likely to occur, save at the first attack of pleuritis. It is probable, but I am not aware of its having been clinically established that a friction-sound indicative of tuberculous disease is more apt to be observed in females than in males, owing to the greater part which the superior costal type of respiration performs in their respiratory movements.

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[1] Western Lancet, Cincinnati, Oct. 1850.

Finally, a friction-sound is occasionally observed in certain structural affections giving rise to asperities or irregularities of the pleural surfaces, such as cancers and tumors of different kinds. These affections are, however, very infrequent; and in its diagnostic relations to them the sign is of very little value. The sign here, and in all cases, merely indicates that the pleural surfaces are roughened. If, in connection with the sign, there are the symptoms, past or present, of intra-thoracic inflammation, and the sign be situated in the middle or inferior portion of the chest, it indicates, in forty-nine of fifty cases, pleuritis, either primary or secondary. If it exists at the summit of the chest within a circumscribed space, and is associated with symptoms leading to the suspicion of tuberculosis, it is highly significant of that affection. And if it be found under circumstances in which neither pleurisy nor tubercle are evidenced by associated signs and symptoms, it proceeds from emphysematous tumors or other affections, the nature of which may not be determinable.[1]

The discovery of a pleural friction-sound as a physical sign, was made by M. Honoré, a contemporary with the discoverer of auscultation.[2] He brought to Laennec a patient presenting the sound, to which the latter applied the title of the rubbing sound of ascent and descent (*bruit de frottement ascendant et descendant*). Laennec, however, as already stated, failed to perceive its connection with pleurisy, but attributed its production to interlobular emphysema. The merit of pointing out more fully its characters, and determining its true pathological significance, belongs to a French observer, M. Raynaud.[1]

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[1] Dr. Walshe states that intra-thoracic friction is sometimes simulated by the movements of the scapula in breathing.

[2] Vide Treatise on Mediate Auscultation, etc., by Laennec.

PHENOMENA INCIDENT TO THE VOICE.

With a previous knowledge of the vocal phenomena pertaining to different portions of the respiratory system in health, the abnormal modifications are readily apprehended. The more important of the vocal signs of disease consist of the characteristics of the normal bronchial and tracheal or laryngeal voice, transferred to situations where they are not found in a healthy condition. This class of signs will constitute one division of the morbid phenomena incident to the voice, comprising *exaggerated vocal resonance* and *bronchophony*. Under this head are comprehended all abnormal modifications, in which the intensity of the normal vesicular vocal resonance is morbidly increased, or gives place to a sound not only more intense than belongs to health, but presenting other of the characters which pertain to the normal bronchial, tracheal, or laryngeal voice. It suffices for all practical purposes to include simply exaggerated resonance and bronchophony, in a single division; and although, strictly speaking, there is an inaccuracy in applying the term bronchophony to a sound more intense than the normal bronchial, and even the tracheal or laryngeal voice, it is admissible for the sake of convenience, and is sanctioned by conventional usage. It would be not less inaccurate to designate an intense vocal sound in any part of the chest, by the terms tracheophony or laryngophony, although identical in character to that observed on auscultating the larynx or trachea. The signification of the term bronchophony is extended by all writers to embrace sounds, the intensity of which equals and sometimes exceeds the tracheal and laryngeal voice. It is usual, also, to make a distinction between exaggerated vocal resonance and bronchophony, the former expression denoting simple increase of the vesicular resonance, and the latter in addition to intensity, alterations in other particulars of the vocal sound. The distinction, as will be seen, is a valid one, but I can see no practical advantage in treating of them under distinct heads, and, therefore, with a view to simplify the subject, I have included both in the same division. To distinguish the gradations of bronchophony, the terms *weak* and *strong*, may be employed. The expression, weak bronchophony, denotes that the distinctive characters are but little or moderately marked; and the bronchophony is said to be strong, when, in intensity and other features, it is considerably or extremely marked. To indicate different degrees of simply exaggerated vocal resonance, adjectives of quantity, such as little, moderate, much, great, etc., are sufficiently exact for all practical purposes.

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[1] Vide Barth and Roger.

The normal vocal resonance may not only be increased to a greater or less extent, but on the contrary, diminished and suppressed. Morbid changes in this direction will constitute another division of vocal signs, which may be distinguished by the simple expressions *diminished and suppressed vocal resonance.*

In treating of auscultation of the voice in health, it was seen that when the stethoscope is applied over the trachea or larynx, frequently articulate words are found to enter the ear, sometimes perfectly, and in other instances partially. This, which very rarely, if ever, occurs over the chest in health, is sometimes observed in disease, and constitutes a distinct physical sign, called *pectoriloquy*. This will claim separate consideration, and constitutes the third of the divisions of abnormal vocal phenomena.

A fourth vocal sign consists of a partial transmission of the voice, elevated in pitch, and tremulous; which, after Laennec, is called, from its resemblance to the bleating of the goat, *ægophony*.

Agreeably to the foregoing divisions, the phenomena incident to the voice in disease may be arranged under four heads: 1. Exaggerated resonance and bronchophony. 2. Diminished and suppressed vocal resonance. 3. Pectoriloquy. 4. Ægophony. Of these four classes of signs, the two first are by far the most important in a practical point of view; in other words, the objects to be attained by auscultation of the voice with reference to diagnosis, chiefly relate to the increase or diminution of the normal vesicular vocal resonance. Now to determine, in individual cases, whether the normal vesicular vocal resonance be increased or diminished, it is necessary to know what is the normal amount of vocal resonance. It has been seen that this varies considerably in different persons, so that neither the amount proper to any single individual, nor the mean intensity of a series of examinations, will serve as a standard for comparison. Here, as in other instances, it is necessary to judge of an abnormal deviation by comparing one side of the chest with the other. But in instituting this comparison, an important consideration is to be taken into account, viz., it has been seen that in health, there does not exist perfect correspondence between the two sides of the chest as respects the degree of the normal vocal resonance. Happily the variations in the two sides are found to observe a certain rule, which must be borne in mind, in order to avoid attributing to disease what may be due to a disparity entirely compatible with health.

1. Exaggerated Vocal Resonance, and Bronchophony.—After the foregoing remarks, a brief description of the characters distinctive of these vocal signs will suffice. With the ear applied to certain parts of the healthy chest, for example, the infra-clavicular region, in front, or the infra-scapular, behind, the act of speaking generally occasions a certain diffused, dull resonance, the sound appearing to come from a distance, and accompanied with a feeble vibration or thrill. This is the normal vesicular vocal resonance. Now this normal resonance may be rendered by disease more intense, in other characters than intensity remaining the same as in health. The vocal resonance is then simply exaggerated. The reverberation of the voice is abnormal, and there is usually more vibration or thrill felt by the ear; but the sound is still distant, diffused, and dull. If, however, well marked bronchophony become developed, not only is the resonance usually greater, but the sound acquires a certain concentration and clearness; the voice seems to be near the ear, while the accompanying vibration may or may not be proportionally great. The distinction, thus, between simply exaggerated resonance, and well-marked morbid bronchophony, is real, and the two signs may be clinically discriminated from each other without difficulty. It is not therefore strictly correct to say that they are essentially identical, the difference consisting only in the degree of intensity of the resonance. But it is true that both may proceed from similar physical and pathological conditions; and that, in diagnosis, their significance is not materially different. Moreover, exaggerated resonance not infrequently merges into bronchophony, and, again, the latter, in the progress of the same disease, may give place to the former. Hence, it is not very essential, practically, to observe always with precision the distinction; and for this reason I do not give to each separate consideration. The vibration or thrill, it is important to note, does not always increase in a uniform ratio to the exaggeration of the resonance, the clearness and concentration of the sound, and the apparent proximity to the ear, pertaining to the thoracic voice. In

strong bronchophony, the ear sometimes receives a shock or concussion, like that felt in auscultating the trachea or larynx, which may even be painfully intense. In other instances, the fremitus seems to be not greater than belongs to health. The sound sometimes has a metallic, ringing tone. Occasionally it is somewhat tremulous. The latter is peculiar to the aged. In degree, both exaggerated vocal resonance and bronchophony present, in different cases of disease, great variations. The intensity of the thoracic voice may exceed that of the normal laryngeal or tracheal. This is a fact not only interesting, but important in its bearing on the explanation of the mechanism by which morbid bronchophony is produced. Another fact, also interesting, and in the same point of view important, is, the pitch of sound is not in all instances identical with that of the normal laryngeal or tracheal voice. Both the foregoing facts are sufficiently attested by observations, but they are to be regarded in the light of exceptions to the general rule. Finally, abnormal intensity of the thoracic voice continues, certainly in the large majority of cases, constantly; that is, it is always found on auscultation, so long as the pathological conditions of the lung to which it is incident continue; in other words, it is not an intermitting sign, like the bronchial rales, now present, and now absent, but steadily presisting for a certain period, in this respect resembling the crepitant rale and the bronchial respiration. This last statement is in direct opposition to the opinion of Skoda, who maintains that the alternate absence and presence of the thoracic voice is a well-known and a common occurrence, and that bronchophony may appear and disappear several times in the course of a few minutes.[1] The question is one to be settled purely by observation, and the experience of others does not sustain Skoda's assertion. Intermittency is an important point in the support of certain theoretical views entertained by Skoda, which will be briefly noticed presently; and this circumstance, it may be remarked, does not tend to enhance confidence in the accuracy of the observations on which his opinion is professedly based, without intending by this remark to convey an imputation of want of good faith.

The recognition of exaggerated vocal resonance and bronchophony, practically, involves no difficulty. It is sufficiently easy to determine, on comparison of the two sides of the chest in corresponding situations, a disparity in the degree of resonance, and the several characters pertaining to bronchophony. There is no liability of confounding these with other signs. The only error to be guarded against is, attributing to disease differences between the two sides which exist normally. Under the head of Auscultation in Health it has been seen that normal differences are observed in a large proportion of persons. They observe, however, a regular law, viz., the greater relative intensity is on the right side; and this is frequently found to be the case over all the regions on this side, but it is especially marked at the summit in front. Exaggerated vocal resonance may be said to exist naturally at the superior anterior portion of the right chest, in a large number of individuals, amounting, in some instances, to bronchophony. From this fact it follows that the resonance on the right side must be considerably greater than that on the left, to warrant the inference that it proceeds from disease; while a slightly greater resonance on the left than on the right side, is highly significant of a morbid condition. The coexistence of other signs incident to the same physical conditions, is a safeguard against the mistake of confounding morbid with natural variations.

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[1] Translation, by Markham. Am. ed. page 68.

The physical condition of which exaggerated vocal resonance and bronchophony are the signs, in the great majority of the cases of disease in which either is present, is increased density of the pulmonary structure. They occur in the different affections which give rise to the broncho-vesicular and the bronchial respiration, and are generally found in combination with these signs. Bronchophony is more uniformly present, and is most strongly marked, in connection with the solidification incident to the second stage of pneumonitis. In that disease, the situation in which it is observed is usually the middle and lower thirds of the posterior surface of the chest on one side, the seat of the inflammation, in the adult, being the inferior lobe, save in a small proportion of cases. It is in pneumonitis especially that the bronchophony is strong or intense, the voice seeming to be very near the ear, attended by concussion or shock, the pitch sometimes notably higher than on the unaffected side, and the sound occasionally somewhat metallic in its tone. As respects the loudness of resonance, however, and the presence of the other characters, different cases of pneumonitis present great variations, dependent on differences in the degree of solidification, on more or less obstruction of the bronchial tubes, and other circumstances less obvious. The character of the voice, other things being equal, probably exerts an influence on the intensity of the sign; but with reference to this point, different observers entertain discrepant opinions. Laennec, Fournet, C. J. B. Williams, and Hughes, regard a treble voice as favorable for transmission throughout the chest, and, hence, bronchophony, other things being equal, is stronger in females and children than in males. Barth and Roger, and Walshe, on the other hand, think that a grave tone conduces to a greater development of the sign, and that it is most likely to be marked in males and adults. The strength of the resonance will be proportionate to the power of the voice, irrespective of its pitch or special quality. These, and other circumstances, such as the thickness of the muscular and adipose layers covering the chest, affect, of course, the resonance in health as well as that incident to disease. The difference of opinion among different observers just referred to, is perhaps due to their attention not being directed to the same elements of those entering into the thoracic voice. The reverberation and vibration are greater, *cæteris paribus*, in persons whose voices are grave or bass; but the force or extent with which the voice penetrates the ear is probably greater when the pitch of the oral voice is high. Bronchophony is not present in all cases of pneumonitis, and in some instances the vocal resonance is not even exaggerated, so that absence of either or both of these signs, by no means affords positive evidence against the existence of the disease. They are present, however, in a greater or less degree, in the great majority of instances. They may be present without being associated with bronchial respiration, and in such instances they are highly important with reference to the question of solidification.

Next to pneumonitis, the affection in which exaggerated vocal resonance and bronchophony are most frequent in occurrence, and most important as physical signs, is phthisis. A tuberculous deposit gives rise to a resonance exaggerated, or to bronchophony, which is strong in proportion to the quantity of tubercle, the degree of solidity which it induces, its extension to the superficies of the lung, and its proximity to the larger bronchial tubes. It is sufficiently intelligible that these circumstances will affect the amount of exaggeration, or the intensity of the bronchophony, in addition to the strength and character of the voice of the individual, etc. Owing to the diversity pertaining to the physical conditions favorable for the production of these signs, different cases of tuberculous disease differ greatly as respects their presence and their prominence. Even an exaggerated resonance may not be appreciable in some instances in which a considerable quantity of tubercle exists. For example, if a tuberculous mass be separated, on the one hand, from the larger bronchial tubes, and, on the other hand, from the walls of the chest, by layers of healthy lung, the vocal resonance may scarcely, if at all, exceed a normal degree of intensity. It is probable, also, that accumulation of mucus or other morbid products in the bronchial tubes may occasion the temporary suspension of the thoracic voice. Its presence, therefore, as necessary to the diagnosis, is much less to be counted on even than in pneumonitis; nor is the intensity with which it may be present to be considered as indicating the abundance of the deposit. Bronchophony is much oftener absent in phthisis than in pneumonitis, and it is very rarely so strongly marked in cases of the former, as it is in the larger proportion of the cases of the latter disease. Hence its value is less in phthisis. Occurring in connection with tuberculous disease, bronchophony and exaggerated resonance are almost invariably situated at the summit of the chest, in the infra-clavicular, and scapular regions, oftener the former. They do not extend over so large a space as in cases of pneumonitis affecting either the lower or upper lobes, being usually limited to a circumscribed area. These are distinctive features of the signs as incident to tubercle; but the history and symptoms, in conjunction with all the physical signs, rarely render it a difficult problem to decide between pneumonitis and tuberculosis. It is in the diagnosis of phthisis, especially, that the normal variations in vocal resonance at the summit of the chest are important to be borne in mind. Exaggerated resonance on the right side, contrasted with the left, and even bronchophony, alone, are not evidence of the presence of the deposit of tubercle; while a slight exaggeration on the left side, in itself, is sufficient ground for presumption that the deposit exists.

Increased density of the lung, in consequence of compression by the accumulation of liquid within the pleural sac, may give rise to exaggerated vocal resonance and even bronchophony. Under these circumstances the latter is very rarely marked, and frequently both are absent. So true is this, that in a case of pleurisy with effusion, strong bronchophony should occasion suspicion of solidification of lung from some cause, in addition to reduction of its volume by compression; in other words, it would denote either coexisting tuberculosis or pneumonitis. Excepting some instances in which the lung is retained in contact with the walls of the chest by adhesions, the effect of the accumulation of liquid is to remove it to the upper and posterior part of the chest. Bronchophony or exaggerated resonance, if either exists, will then be heard at the summit, in front or behind. It is sometimes limited to the site posteriorly of normal bronchophony, viz., over the upper part of the interscapular space, but is, by no means, constantly present even in that situation. Over the portion of the chest corresponding to the space occupied by the liquid, the resonance is not exaggerated certainly in the vast majority of cases, and this is to be taken into account in determining the fact of pleuritic effusion; while existing over the inferior part of the chest, it indicates the presence of solidified lung.

Serous infiltration or œdema occasions increased density of the lung, and may give rise to exaggerated resonance. Marked bronchophony, however, is very rarely, if ever, developed in this affection; and both signs are frequently absent.

In the rare forms of disease in which a portion of the lung is solidified by carcinomatous or melanotic deposits, extravasated blood, gangrene, the typhoid material, syphilitic induration, and also in cases of extra-pulmonic morbid growths, exaggerated resonance and bronchophony may or may not be present. The circumstances which should lead the diagnostician to attribute the presence of these signs to some one of these affections, instead of the more common morbid conditions to which they are incident, are the same that have been noticed in connection with the subject of bronchial respiration, to which the reader is referred. In general terms, if the exaggerated resonance or bronchophony be circumscribed in extent, not confined to the summit, but situated in any part of the chest, and persisting (these circumstances excluding the diseases previously referred to), we may infer the existence of some one of the affections just enumerated. In determining which one of these several affections exists, in individual cases, we are to be guided by the circumstances associated with the physical signs; for example, the expectoration of blood in pulmonary apoplexy, and of fetid matter in gangrene; the pre-existence of typhoid disease, or syphilis, etc.

It has been stated that, of the instances in which the signs under consideration occur, in the vast majority, the physical condition is increased density of lung. As an exception to this rule, exaggerated resonance and even bronchophony have been sometimes observed in an affection characterized by abnormal rarefaction of lung, viz., emphysema. Their occurrence, however, is exceptional as regards the physical signs of that affection,—the rule being a degree of vocal resonance not exceeding, and frequently falling below that of health. To the fact of their occasional presence in a marked degree in emphysema—a fact not generally stated by writers on physical exploration—Dr. Walshe has particularly called attention.[1]

Dilatation of the bronchial tubes is another morbid condition in which exaggerated vocal resonance and bronchophony occur. In this rare lesion, the dilated bronchiæ are surrounded, to a greater or less extent, with condensed or indurated lung, so that it is difficult to say what is the relative proportion of the exaggerated resonance or bronchophony, which is fairly attributable to the enlarged calibre of the tubes. Bronchophony is not constantly associated with the lesion, and is present in different instances with variable degrees of intensity, sometimes being very strongly marked, when the dilatation coexists with considerable induration of the surrounding lung.

The mechanism of bronchophony, as of some other physical signs, offers scope for much theoretical discussion. In a practical point of view, it is not very important; nor is uniformity of opinion in regard to it necessary to agreement in so much of the principles and practice of auscultation as relates to the availability of the sign in the diagnosis of diseases. To this part of the subject, therefore, as in other instances, I shall devote but little space, referring the reader who may desire a more extended consideration of it, to works which professedly treat at length of the physical principles involved in the production of auscultatory phenomena. Laennec attributed the phenomena pertaining to the thoracic voice, to the greater conducting power of lung, when its density is increased. According to this explanation, the vibrations of the vocal chords, and of the air within the larynx, are propagated downward along the walls of the bronchial tubes, or the air contained in the tubes, or through the medium of both, and are heard in diseases attended by solidification of lung, with more intensity than in health, simply because solidified lung is a better conductor of sound than air-vesicles filled with air. This explanation has generally been accepted as satisfactory, until recently it has been found there are certain difficulties which it does not fully meet, and it has been attempted by Skoda to disprove altogether its correctness, and to substitute another theory, to which reference has been made in treating of bronchial respiration. The theory of Skoda attributes bronchophony, as well as the bronchial respiration, to the reproduction of sonorous vibrations within the bronchial tubes, in accordance with the musical principle of consonance. The bronchial tubes, according to him, take no direct part in the mechanism; that is to say, he excludes vibration of the walls of the tubes from any participation in the resonance, regarding the column of air contained within the tubes as alone concerned in the production of the thoracic sound. In the normal condition of the lungs, the consonating sounds are slight, owing to the smaller bronchial tubes being membranous, and the want of firmness in the surrounding parenchyma; but whenever the density of the lung is increased, provided the tubes remain pervious, the physical conditions necessary for stronger consonance are present; and hence, bronchophony is developed[1] under these circumstances. In support of this theory, it is assumed by Skoda that bronchophony is absent whenever the bronchial tubes are obstructed, and that it appears and disappears frequently within a brief space of time, owing to the alternate removal and accumulation of mucous secretions. This, to the extent asserted by Skoda, is at variance with common observation. That obstruction, especially of the larger tubes, may occasion a suspension of the sign, and affect its intensity, is probably true; but it is certainly not so dependent on the presence or absence of mucous secretions in the smaller subdivisions of the bronchiæ, as Skoda assumes. Its constancy in cases characterized by cough and abundant expectoration is incompatible with that position. This consideration alone renders the theory of consonance inadequate, in itself, to account for the phenomena of bronchophony. In disproval of Laennec's doctrine of conduction, Skoda declares, as the result of experiments on hepatized lung removed from the body, that the conducting power is less than that of healthy lung; and that, hence, if exaggerated resonance depended on conduction alone, it should exist in health rather than when the pulmonary structure is solidified by disease. The experiments on which this opinion is based, consist in listening with the stethoscope applied over a portion of solidified lung, while another person speaks through a stethoscope applied over parts of the same lung, more or less distant. It is obvious that such experiments do not fairly represent the circumstances under which bronchophony takes place in the living body, unless it be gratuitously assumed (as it is by Skoda), that the column of air in the bronchial tubes is the only agent concerned in the mechanism. Even with this assumption, the cases are hardly parallel. But, as already remarked in connection with bronchial respiration, others, in repeating the same experiments, do not arrive at the same conclusion. Dr. Walshe has found that different specimens of hepatized lung do not conduct sound equally, a fact according with the variations in the intensity of vocal resonance, which are clinically observed in different cases of pneumonitis, but that in some instances, the sound is conducted with great intensity. Again, as stated by Walshe, if a person speak through a stethoscope introduced into the trachea of a subject dead with pneumonitis, in a case in which bronchophony had been marked during life, and another person listen to the chest, there is often nearly complete absence of sound. Here are the physical conditions for consonance, provided the bronchial tubes are unobstructed. Skoda endeavors to explain the non-production of sound in this experiment, by assuming that, after death, the smaller tubes are always filled with fluid; but, according to Walshe, close examination showed this not to have been the case in some of the subjects on which the experiment was made. But there are other and more positive considerations, which render the theory of consonance untenable. A consonating sound always sustains a fixed harmonic relation to the original sound upon which it depends. The two sounds must be in unison. Now it is a matter of observation that the sound heard over the chest, and that heard over the larynx of the same patient, are not always in harmonic relation to each other: in other words, musically speaking, they are discords. Again, air contained within a certain space is capable of being thrown into consonating vibrations, only with certain notes which correspond to, or are in unison with the fundamental note of the space. But bronchophony is produced by speaking in various tones; some of which must be at variance with the fundamental note of the space in which the consonating vibrations are imagined to take place. Finally, a consonating sound, except under conditions which the pulmonary organs cannot furnish, is always very much more feeble than the original sound; yet, the thoracic voice is sometimes more intense than over the trachea or larynx. The theory of consonance, therefore, is at variance with the laws of acoustics.[1]

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[1] Op. cit.

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[1] The same explanation of bronchophony was offered many years ago by Dr. E. L. Carr, in a paper read to a medical society, but not published. Vide, Buffalo Medical Journal, vol. viii. 1853.

The doctrine of Laennec, which, as has just been seen, is by no means disproved, nevertheless fails to account for all the phenomena of bronchophony. As already remarked, the thoracic voice has been observed to be intense, when the lung, instead of being condensed, is actually rarefied, viz., in emphysema. Moreover, simple conduction is inadequate to explain the intensification of sound which, although infrequent, does occasionally take place within the pulmonary organs; and it is equally inadequate to explain the variation of pitch sometimes observed between the laryngeal and the thoracic voice. The vocal sounds must be, in certain instances, at least, in some way reinforced within the bronchial tubes, and also receive there modifications of its quality and tone. Consonance may be one of the subsidiary agencies involved. In addition to this, and to the influences which the sound receives in passing by conduction through different media, reflection and reverberation probably take place, constituting what is distinguished as union-resonance and echo. From some of the examples employed by Skoda to illustrate his theory of consonance, it would seem that under this title he intended to comprehend the acoustic principles referred to by the terms just mentioned.[1] With the foregoing brief discussion, which, in view of the practical objects of this work, has been perhaps already too extended, I leave the consideration of the mechanism of bronchophony, repeating the remark, that the subject is one chiefly of speculative interest; for, whether the theory of consonance be received or rejected, is a matter unimportant so far as the significance and value of the sign are concerned, our knowledge of the latter being based solely on clinical and autopsical observations.

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[1] The author would express his indebtedness for the foregoing points, to the admirable work of Dr. Walshe (edition for 1854); to which also he would refer the reader desirous of a fuller consideration of the subject.

An incidental phenomenon which was noticed in treating of healthy vocal resonance, is of interest and importance in connection with bronchophony as a sign of disease. I refer to a *souffle* or blowing sound accompanying words spoken aloud, but which is apt to be obscured by the resonance and vibration, and is therefore more satisfactorily observed when words are whispered. In cases of pneumonitis or tuberculosis, if the naked ear or stethoscope be applied over the solidified lung, the other ear being closed (a precaution always to be employed in auscultating for vocal resonance), and the patient requested to count in distinct and tolerably loud whispers, a bellows sound, more or less loud, will be found to accompany each enunciated numeral. On comparing the result of the same procedure on the healthy side in a corresponding situation, a sound in the latter instance will either be entirely wanting, or it will be notably more feeble, and also lower in pitch. A relatively intense and high-pitched *souffle*, accompanying the act of whispering, is thus a physical sign having the same significance as bronchophony, and the bronchial respiration. In the character of the sound it is analogous to the latter. This sign is not only worthy of attention, as co-operating with bronchophony and bronchial respiration, and thus serving to confirm their validity, but it may be strongly marked in some instances in which the other signs just mentioned are imperfectly developed. In the latter point of view, it deserves more consideration than it has received from writers on physical exploration.

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[1] For a full exposition of the principles of conduction, union-resonance, and echo, so far as they relate to this subject, the reader is referred to the treatise by Dr. Walshe.

In conclusion, the phenomena which have been presented under the head of exaggerated vocal resonance and bronchophony, taking into consideration, in individual cases, the situation in which they are observed, the space over which they are found to extend, their intensity, and their conjunction with other physical signs together with symptoms, are often of considerable value in diagnosis.

2. Diminished and Suppressed Vocal Resonance.—The effect of certain morbid conditions is to diminish or suppress the normal vocal resonance. If, therefore, it be apparent that the resonance proper to any part of the chest in health is lessened or absent, evidence is thereby afforded of the existence of some one of the morbid conditions which are known to produce this effect. There being no fixed standard of normal vocal resonance, its diminution, as well as its increase, is determined by a comparison of the two sides of the chest. In the one case, not less than in the other, it is important to take cognizance of the normal disparity existing between the two sides in a large number of individuals, and also of the fact that the relatively greater degree of resonance is naturally on the right side. Without due regard to the latter fact, the less amount of resonance on the left side so frequently found in health, might be attributed to disease situated in that side, as well as *vice versa*. An abnormal disparity between the two sides, provided the greater resonance on one side do not exceed an amount compatible with health, may proceed from a morbid diminution on one side, or from a morbid exaggeration on the other side. In the one case, the disease is seated in the side in which the resonance is relatively less; in the other case, the affected side is that on which the resonance is relatively greater.

Without the co-operation of other signs, or of symptoms, it would sometimes be difficult to determine, under these circumstances, to which side the disease is to be referred; but with the information to be derived from other sources, there can hardly be much room for doubt on this score in any instance.

The morbid conditions to which diminished vocal resonance is incident are emphysema, certain cases of solidification, obstruction of one of the large bronchi, the presence of abundant liquid effusion, and of air in the pleural sac. Of these several conditions, in the two first, viz., emphysema and solidification, the normal resonance is diminished, not uniformly, but in a certain proportion of cases only. In emphysema, diminution is the rule, but in some exceptional instances the resonance is notably increased. In solidification, the resonance is generally increased. It is in connection with this condition, as has been seen, that exaggerated vocal resonance and bronchophony occur in the great majority of instances. As exceptions to the general rule, however, an opposite effect is sometimes induced. Cavities filled with liquid products also occasion a notable diminution of resonance within a circumscribed space corresponding to the side of the excavation. Obstruction of one of the large bronchi diminishes the resonance in so far as the column of air within the bronchial tubes takes part in the propagation of vocal sounds, and, perhaps, also, in consequence of the changes induced in the lung in which the circulation of air is cut off. In pleuritis, hydrothorax, and pneumo-hydrothorax, the diminution of resonance is the rule, and in these affections suppression is often observed. The presence of liquid in the two former affections, and of air together with liquid in the one last mentioned, remove the lung so far from the thoracic walls that the vocal vibrations emanating from the larynx, as well as the respiratory sounds, fail to reach the ear of the auscultator; or, if appreciated, are feeble and distant. Absence of vocal resonance, or abnormal diminution, are to be embraced among the signs by which the presence of liquid, or of liquid and air, is to be determined. It is chiefly in this application that the sign possesses clinical value; and inasmuch as the diagnosis of these affections is usually not attended with difficulty, diminution and suppression of vocal resonance are to be ranked among the signs of minor importance. Nevertheless, in accumulating evidence in order to arrive at a conclusion with the utmost positiveness, a feeble and distant vocal sound on the affected side, or the absence of resonance, is a point entitled to weight, and should not be overlooked.

3. PECTORILOQUY—CAVERNOUS AND AMPHORIC VOICE.—The distinctive characteristic of pectoriloquy, as the name imports, is the transmission, not simply of vocal sound, but speech: the articulate words are appreciated by the ear applied to the chest. This characteristic is sufficient to distinguish it from bronchophony, but, as will be presently seen, there is not much practical advantage in regarding it as a distinct physical sign; and at the present time some writers treat of it as a modified form or variety of bronchophony.[1] It is accompanied by bronchophony in a certain proportion of cases, but not invariably. The type of pectoriloquy is to be found among the phenomena incident to the voice in health. With the stethoscope placed over the trachea or larynx, the ear, in a small proportion of instances, receives with distinctness the words enunciated by the person examined. In most instances the articulated voice is not perfectly transmitted through the instrument, but heard with more or less indistinctness. The nature of the sign, and its different degrees of completeness, may thus easily be made familiar practically, by auscultating the trachea and larynx of different individuals. This phenomenon does not pertain normally to any portion of the chest, but it may be presented in connection with certain morbid conditions, and then constitutes true pectoriloquy, or chest-talking. The intensity with which the words enter the ear may even be greater than when the stethoscope is applied over the larynx or trachea.

Laennec regarded pectoriloquy as a pathognomonic sign of a pulmonary cavity. He divided it into three varieties, viz., perfect, imperfect, and doubtful. In perfect pectoriloquy the transmission of the articulated voice is complete; in the imperfect variety, the words are indistinctly heard; and when doubtful, it is not distinguishable from bronchophony, save by circumstances other than those pertaining to the voice. It is evident that in giving to pectoriloquy this comprehensive scope, as regards its audible characters, together with so limited an application in its diagnostic significance, Laennec was influenced by the desire manifested in other instances to establish for each particular lesion a special physical sign. Taking his own description of doubtful and incomplete pectoriloquy, these varieties are neither more nor less than bronchophony. So far as distinctive characters are concerned, Laennec did not attempt to draw the line of demarcation. According to him, bronchophony is, in fact, pectoriloquy, whenever, from its situation, the general symptoms, and the progress of the disease, it may be deemed to proceed from a cavity.[1] Observations since the time of Laennec have abundantly disproved the hypothesis of the transmission of speech, even when most complete, being always due to the presence of a cavity; and, at the present time, pectoriloquy, be it ever so perfect, has not the significance which it possessed in the estimation of the illustrious founder of auscultation.

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[1] Walshe, Skoda.

The physical condition, irrespective of excavation, to which pectoriloquy is sometimes incident, is solidification of lung, either from inflammatory or tuberculous deposit. Exaggerated vocal resonance, to a greater or less extent, coexists. Under these circumstances the sign is, in fact, incidental to bronchophony. The other signs indicative of solidification will be associated with it, viz., notable dulness on percussion, and the bronchial respiration. In both forms of disease, but more especially in pneumonitis, the pectoriloquy will be diffused, *i. e.* heard over a considerable space. In connection with crude tubercle, the situation in which it is found is at the summit of the chest; and it is most apt to occur in pneumonitis affecting the upper lobe. It is by no means frequently present in the affection just mentioned, but only in a small proportion of cases, dependent, it is probable, on a continuous and uniform density of lung between some of the larger bronchial divisions and the thoracic walls.

Cavernous pectoriloquy, however, does occur; that is to say, the sign may proceed from an excavation. But it is perhaps as rarely observed in connection with cavities, as in cases in which the lung is solidified. Tuberculous excavations are sufficiently common, yet it is seldom that well-marked pectoriloquy is developed in the progress of phthisis. Its occurrence cannot therefore be counted on as evidence that the disease has advanced to the stage of excavation. Occurring at a late period, when it is altogether probable, from our knowledge of the pathological history of phthisis, that a cavity, or cavities, have formed, how are we to determine that it is not caused by the solidification from the presence of crude tubercle, which frequently exists in the vicinity of the excavations? The circumstances on which this discrimination is to be based are not so much any peculiarities of character, as its intermittence when due to a cavity; its being limited to a circumscribed space, and associated with other physical signs indicative of excavation, viz., tympanitic resonance on percussion, with, in some instances, the *bruit de pot fêlé*, and the cavernous respiration, alternating with gurgling rales. If these circumstances were not conjoined, in many if not in most instances it would not be easy to determine whether the pectoriloquy be or be not cavernous. The point, happily, is one of clinical curiosity, rather than of much practical importance. Cavernous pectoriloquy requires the conjunction of several conditions. The cavity must be of considerable size. It must communicate freely with the bronchial tubes. It must be free, or nearly so, of liquid. It must be situated near the walls of the chest, and the sign is more likely to be produced if adhesion of the pleural surfaces have taken place over the part of the lung in which it is situated, so that, in addition to the thoracic walls, a thin condensed stratum of pulmonary structure alone intervenes between the exterior of the cavity and the ear of the auscultator. The walls of the cavity must be sufficiently firm not to collapse when it is empty. The space within the excavation must not be intersected by parenchymatous bands. The infrequency with which these several conditions are united, accounts for the absence of the sign, as a general rule, even when cavities exist, and for its being transient or intermittent in cases in which it may be sometimes discovered.

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[1] Vide Treatise on Diseases of the Chest, etc. Translated by Forbes, page 39, New York edition, 1830.

In by far the greater proportion of the instances in which cavernous pectoriloquy occurs, the excavations are due to tuberculous disease. It may, however, be incidental to the cavities resulting from circumscribed gangrene and abscess. But, in addition to the great infrequency of the latter affections, the favorable conditions are less likely to be combined than in tuberculous excavations. It may also occur in some cases of perforation of the lung, establishing a communication between the bronchiæ and the pleural cavity, giving rise to pneumo-hydrothorax. In that rare lesion in which a pulmonary cavity is simulated, or rather virtually exists, viz., pouch-like dilatation of the bronchiæ, pectoriloquy may be strongly marked.

The voice resounding in a cavity of considerable size, sometimes assumes a musical intonation, resembling the modification which the vocal sound receives on speaking into an empty vase or pitcher. This constitutes what is called, from the similitude just mentioned, *amphoric* voice. The character is analogous to that belonging to the respiratory sound to which the same title is applied. It has no special significance beyond denoting the existence of a cavity, but, inasmuch as when it is strongly marked, it probably proceeds from an empty space, while ordinary pectoriloquy may be due to solidification, it has a positive diagnostic value in the rare instances in which it is heard. It occurs not only in pulmonary excavations, but in cases of pneumo-hydrothorax, with a fistulous communication between the bronchial tubes and the pleural sac. The characteristic sound is not necessarily accompanied by the transmission of speech. An amphoric voice, therefore, may with propriety be regarded as a sign distinct from pectoriloquy. It is so regarded and treated of under a separate head by some writers.[1] It suffices, however, for all practical purposes to notice it thus incidentally and briefly in the present connection.

Pectoriloquy does not sustain any constant relation to the intensity of thoracic resonance and the associated thrill, nor is it dependent on the loudness of the oral voice. The speech may be distinctly transmitted without being associated with the phenomena combined in well-marked bronchophony, and also when the patient is unable to speak except feebly, or only in whispers; in some instances the words emanating from the chest have been observed to be even louder and more distinct than when received from the mouth. The transmission of whispered words is distinguished as *whispering pectoriloquy*, which is regarded by Walshe as highly distinctive of a cavity. My own observations lead me to a different conclusion. I have repeatedly found well-marked whispering pectoriloquy over solidified lung; and, without having analyzed cases with respect to this point, I should say that it is oftener met with than the transmission of words spoken aloud. This accords with the results obtained by auscultation of the voice in health, viz., whispered words are oftener transmitted over the trachea, larynx, and bronchi; and in a single instance, imperfect whispering pectoriloquy was observed in the infra-clavicular region, while in no instance were words spoken aloud even partially transmitted.

The mechanism of pectoriloquy claims but a few words, inasmuch as the physical principles involved are probably essentially identical with those concerned in the production of bronchophony. Conducted by the air contained within the bronchial tubes and cavity, aided by the bronchial walls and solidified parenchyma, when the intensity of the transmitted speech is considerable, the sound is probably reinforced by reflection from the walls of the excavation, and possibly, also, to some extent, by consonance, according to the theory of Skoda.

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[1] Barth and Roger.

[2] Vide Auscultation of the Voice in Health, page 168.

The amphoric modification of the vocal resonance is probably due to reverberation of sound within the cavity giving rise to a kind of echo. Skoda entertains the opinion that the development of the amphoric voice does not require a free communication between the cavity and the bronchial tubes, but that the necessary sonorous vibrations may be excited within the former, provided a thin layer of tissue only intervenes. Barth and Roger concur in this opinion.

Pectoriloquy is an interesting physical sign, from the fact that it was the first observed by Laennec, and led to the application of auscultation to the investigation of pulmonary diseases. As respects its value in diagnosis, since it has been ascertained to accompany bronchophony in a certain proportion of cases of solidification, and to occur very infrequently in connection with cavities, it cannot be considered to possess much practical importance. Barth and Roger propose to dispense with the use of the term pectoriloquy, and under the title of cavernous voice to include only the instances in which speech is transmitted from cavities. But so far as the sign alone is concerned, it cannot be determined whether it proceed from a cavity or not. This point is to be settled, not by the evidence received through the sense of hearing, but by reasoning on the circumstances with which the sign is associated. In other words a cavernous voice, exclusive of the amphoric voice, does not exist as a distinct physical sign. The distinction is consequently arbitrary. The reality of pectoriloquy, that is, the transmission of speech, as distinct from bronchophony, even when the two are associated, as is frequently but not invariably the case, is unquestionable. Its distinctive character is very clearly defined. It has therefore just claims to be recognized as an individual physical sign, although, as has been seen, it represents anatomical conditions precisely opposite in character. Its pathological significance is always to be determined by the part of the chest in which it is situated; the extent of surface over which it is heard; its constancy or persistency; and the other physical signs together with the symptoms which accompany it.

4. ÆGOPHONY.—The modification of the thoracic voice thus entitled, has given rise to much discussion respecting its pathological significance, as well as its mechanism. Limiting the attention almost exclusively to the former of these two aspects of the subject, I shall not devote to it extended consideration, especially, as will be admitted by all practical auscultators at the present time, clinically, the sign

is among the least important of those furnished by physical exploration. The characters by which it is distinguished are well defined and distinctive. Its peculiarities are sufficient to establish its individuality; and, when well marked, it is readily recognized. The inferior rank which it holds, results from the infrequency of its occurrence; its superfluousness in certain of the instances in which it is observed, owing to the adequateness of other signs to the diagnosis; and, according to the opinion of some, the uncertainty which attaches to it as an expression of a particular pathological condition.

The essential features which characterize ægophony are, a peculiar tremulousness of the vocal sound, the pitch being elevated above that of the oral or laryngeal voice. With these characters it frequently bears a striking resemblance to the bleating cry of the goat, and this similarity is expressed in the etymology of the word ægophony, which was employed to designate the sign by Laennec. In its audible character, however, it is by no means always uniform. In some instances a sound is produced which was compared by Laennec to that of the voice transmitted through a metallic speaking-trumpet. Another variety he likens to the peculiar tone of Punch in the puppet-show, produced by speaking in a high key, with the nostrils closed. Hence it is styled by the French, *voix de polichinelle*. The force of the last illustration will be less generally appreciated in this country than in France, performances of Punchinello being as rare in the former, as they are common in the latter. A third variety the same author compares to the sound produced when a person attempts to speak with a *solid* substance between the teeth and lips. It is sufficient to say that the vocal resonance becomes ægophonic whenever the sound is interrupted or tremulous, and the pitch more or less acute; and that these distinctive traits may be presented in various degrees and proportions from strongly marked, pure ægophony, down to the slightest modification in these particulars. The two elements which thus enter into the composition of the ægophonic voice may not be present in an equal ratio. The sound resulting from their combination is by no means uniform. It may be feeble or strong. It may be so faint as to be scarcely appreciable, or the sign may be associated with exaggerated vocal resonance or even bronchophony. It may exist in every degree as respects intensity. The tremulousness may be strikingly marked, or just perceptible, with every intermediate shade. The pitch may be slightly or considerably raised. The bleating, vibrating intonation, accompanies the vocal resonance, but the two do not always occur synchronously. The former sometimes succeeds the latter, so that they may be perceived to be distinctly although slightly separated. The ægophonic sound, as each word or syllable is pronounced, follows the articulation like an echo. The impression of distance is another feature belonging to ægophony; the sound appears to be somewhat removed, and not produced directly beneath the ear of the auscultator.

In addition to the foregoing points pertaining to the audible characters, other distinctive traits relate to the situation where it is usually heard, the extent of its diffusion, etc. Ægophony does not occur indifferently at any part of the thorax. It is found much oftener than elsewhere at or near the inferior angle of the scapula, frequently being limited to a small space, and usually more marked at that situation, when it is more or less diffused. From the point just mentioned, when it is not thus limited, it generally extends, according to Laennec, and other observers, to the interscapular space, and in a zone from one to three fingers broad, following the line of the ribs toward the nipple. This rule as respects situation is not without exceptions. Fournet states, as the result of numerous observations, that it may exist over the greater part of the lateral and posterior portions of the chest, but never extending to the summit. It has, however, been observed in the infra-clavicular region, and also diffused over nearly the entire chest on one side. It is sometimes found to shift its seat, or to disappear when the position of the patient is changed. The explanation of these facts involves a reference to the physical conditions upon which the sign is dependent, and will be noticed presently. Its duration is variable, but rarely extending beyond a brief period. The average time of its continuance is estimated from five to eight days;[1] but in a case of chronic pleurisy cited by Laennec, it lasted for several months. In the progress of the same disease, viz., pleurisy, it may appear, continue only for a short time, and at a subsequent stage reappear for a brief period. This has been repeatedly observed, but is by no means an invariable rule. During the period of its continuance it is pretty constant, *i. e.* heard at nearly every examination; but it is not equally manifested with each act of the voice, or articulated word. It is more intense at some moments than at others, and may be temporarily suspended by an accumulation of mucus in the bronchial tubes, being reproduced immediately after coughing and expectoration.

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[1] Barth and Roger.

Laennec regarded ægophony as conclusive evidence of the presence of a certain quantity of liquid within the pleural sac. He asserts that he discovered it in nearly every case of pleurisy that came under his notice during the period of five years. Subsequent observations have abundantly confirmed the fact of its occurrence in connection with the pathological condition just mentioned, but in a proportion of instances much less than was supposed by the founder of auscultation. With the utmost veneration of the memory of Laennec, it must be presumed that, with reference to ægophony, as in the case of pectoriloquy, a strong desire to invest each sign with a special significance, representing constantly the same anatomical condition, to some extent affected, unconsciously, the accuracy of his observations. This presumption is strengthened by his confession of the difficulty, frequently, of discriminating ægophony from bronchophony and pectoriloquy; and, also, by the importance which he attaches to pressing the ear very lightly against the stethoscope in seeking for this sign. This method of auscultating, suffices often to give to the voice an ægophonic intonation. At all events, it is certain that well-marked ægophony, so far from being constantly or generally present in pleurisy, is one of the rarest of the physical signs, and there are doubtless many who have had considerable experience in physical exploration, without ever having met with a single good example of it. It may be associated with the presence of liquid of any kind between the pleural surfaces, serum, pus, or possibly even blood; and it is therefore a sign which may be incident to ordinary pleurisy, the hemorrhagic variety of the disease, empyema, pneumonitis with liquid effusion, and hydrothorax. Even in the time of Laennec, the uniform dependence of ægophony on the presence of liquid, was doubted by some observers, who professed to have discovered it in cases of simple pneumonitis, involving solidification of lung without liquid effusion. Skoda rejects entirely the special significance attached to it by Laennec, and declares that he has met with it both in simple pneumonitis, and tubercular infiltration. Such instances, if they exist, are certainly exceptional. Without denying their occurrence, it may be suspected that the presence of a small quantity of liquid, sufficient to occasion this sign, but not abundant enough to give rise to other physical evidences of effusion, may be the explanation in some cases.[1] The sharp tremulous character of the oral voice may, also, account for its occasional apparent manifestation. Bronchophony, and the normal thoracic voice, assume frequently an ægophonic character in the aged of both sexes, but especially in females. Moreover, with reference to this point, a distinction is to be made between distinctly marked ægophony, and a slightly ægophonic character of the thoracic voice. The latter may occur as a normal peculiarity, or in connection with solidification of lung, without invalidating the significance which properly belongs to the former. But whether or not well-marked ægophony be sometimes incident to solidification of lung alone, this fact must be admitted, viz., of the instances in which it is observed, in all save a few exceptional cases, it is due to liquid effusion. Observations also have sufficiently established that, in general, it demands for its production a small or moderate amount of liquid effusion. Laennec states that he had discovered it in cases in which there did not exist above three or four ounces of fluid in the chest. A quantity sufficient to produce slight compression of the lung, interposing a thin stratum between the pulmonary surface of the thoracic parietes, appears to furnish the necessary physical conditions. In the progress of pleurisy, the sign, when it occurs, is found at an early period of the disease. Laennec discovered it, in some instances, within a few hours after the attack, but generally not strongly marked until the second or third day. Where the quantity of effusion increases so as to produce considerable compression of the lung, removing it at a distance from the greater part of the thoracic walls, the sign almost invariably disappears. It continues, therefore, frequently but a short time, perhaps for a few hours only, rarely longer than two or three days. Its limitation to a particular juncture in the course of the disease, and its short duration, undoubtedly are reasons why it is not discovered in many cases in which it exists. In some instances it may have occurred and disappeared prior to patients coming under observation. At a subsequent stage of pleurisy, when the quantity of liquid is reduced by absorption to that involving the requisite physical conditions, it is sometimes observed a second time, or it may be discovered under these circumstances, when it had not been observed previously. Returning ægophony (*égophonie de retour*, *ægophonia redux*), thus furnishes evidence of the progress of the disease toward

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[1] Normal ægophony, due to the character of the oral voice in the aged, will be likely to be present on both sides of the chest. This will serve to distinguish it from the

morbid sign which, excepting some rare instances of hydrothorax, is limited to one side. But the character of the oral voice will be apparent. Moreover, the other physical signs of pleuritic effusion will be wanting.

restoration. The dependence of the sign on the presence of a certain quantity of liquid has been demonstrated by its appearance in cases of empyema, in which paracentesis was resorted to, the ægophony, which had not existed prior to the operation in consequence of the large quantity of liquid, becoming developed after a portion had escaped. It has been observed, during the removal of the liquid, to change its place as the quantity lessened, falling lower and lower on the surface of the chest, and finally disappearing after the whole of the fluid contents of the chest had been withdrawn.[1] The fact of ægophony being commonly found at a particular situation, viz., at the lower angle of the scapula, and over a narrow space extending from this point in the direction of the ribs to the nipple (the patient being examined in a sitting posture), has led to the supposition that the peculiar modification of the vocal sound is produced at the level of the liquid; in other words, that the zone just mentioned indicates the height on the chest to which the effusion rises. It is not, however, as has been stated, always limited to the situation described; and, as remarked by Fournet, it is more probable that the points at which the sign is heard, are those where the stratum of liquid has precisely the requisite thinness, the quantity above being too small, and below too large. This conclusion is sustained by evidence afforded by the percussion and respiratory sounds, found above and below the site of the ægophony. Dulness of the sound on percussion, and diminution of the respiratory murmur, have been observed to be progressively and gradually more marked in descending from a certain distance above the limits of the ægophony; flatness and the absence of respiration existing at the lower part of the chest.[2] As exceptions to the general rule, ægophony is occasionally well marked in cases in which the quantity of liquid is quite large, sufficient even to occasion considerable enlargement of the chest. In the rare instances in which ægophony is heard over the greater portion of the chest on one side, the explanation offered by Laennec is, that, owing to adhesions of the pleural surfaces, at numerous disconnected points, the lung is prevented from being pushed upward before the accumulating liquid, which consequently is diffused over the whole pulmonary surface, except where the morbid attachments exist, the stratum being uniformly of the requisite thinness. In two instances he verified the correctness of this explanation by the appearances found after death. The shifting of the seat of the ægophony, or its suppression, when the position of the patient is varied (a point first observed by M. Reynaud, a contemporary with Laennec), is explained by the change of relation, which takes place between the lung and the surrounding liquid. Assuming that the sign requires an intervening stratum of fluid of a certain depth, it is not difficult to conceive that, having been discovered at a particular part while the patient is in the sitting posture, its situation should be found to be movable as the body is inclined to one side or the other, or far forward, in consequence of the relative disposition of the liquid being so changed, that the locality in which the necessary physical conditions are present, varies. It is also intelligible, that a change of position by which the lung displaces a thin stratum of liquid, and comes into contact with the walls of the chest, as when a patient, after having been examined in the sitting posture, lies on the abdomen, should cause suppression of ægophony, or a substitution of simply exaggerated resonance or bronchophony, provided the lung be partially solidified. These phenomena have been repeatedly observed, but by no means uniformly in the cases in which ægophony occurs, which accords with the well-known fact, that it is only in a small proportion of cases that the level of the effused fluid is affected by changes of the position of the patient.

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[1] Barth and Roger, op. cit. p. 202, edition of 1854.

[2] Fournet, op. cit.

In the vast majority of the instances in which ægophony is observed, it is incident to simple pleurisy. It is very rarely found in empyema, the quantity of liquid being too large. It may occur in hydrothorax, and be present on both sides of the chest. It has been known, as an anomalous fact, to accompany hydro-pericardium. In pneumonitis the occurrence of well-marked ægophony is exceedingly rare. It is not, however, very uncommon for the thoracic voice to assume more or less of an approximation toward ægophony. Under these circumstances there is usually exaggerated vocal resonance or bronchophony; these signs, in other words, become ægophonic.[1] Intensity of the thoracic voice, with an ægophonic modification, is to be regarded as diagnostic of solidified lung conjoined with pleural effusion, the vocal resonance in simple pleurisy or hydrothorax being rarely much exaggerated.

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[1] It has been proposed by Dr. Christophe to distinguish a sound intermediate between ægophony and bronchophony by the title of *ægony*—a diminutive of ægophony. There is not, however, sufficient practical importance in the distinction to warrant the introduction of a new technical term.

The mechanism of ægophony is a mooted point which it would be unprofitable to discuss, and I shall give to this branch of the subject but a few words. Laennec attributed the tremulousness of the voice to the agitation of the liquid by the act of speaking. It may be conceived that the vocal sound transmitted through a stratum of fluid under these circumstances, would acquire a corresponding vibratory character. Whether this explanation be correct or not, none other more satisfactory has been offered. The other ægophonic element, viz., the elevation of pitch, Laennec accounted for by supposing that the bronchial tubes, flattened by the compression of the liquid, are made to resemble the mouth-piece of certain musical instruments like the bassoon or hautboy, and that the modification of tone was due to this condition. This theory is generally deemed unsatisfactory, but of the various substitutes that have been proposed, no one has sufficiently commended itself to be generally adopted. The true rationale is yet to be established; and here, as in other instances in which the physical principles involved in the mechanism of signs are undetermined, the question is one of speculative rather than practical interest.

In conclusion, from the facts contained in the foregoing account of ægophony, its claims to be recognized as a veritable individual sign appear to me to be not less valid than those of pectoriloquy. Like the latter sign, it has distinctive traits, by which, when well-marked, it is distinguished without difficulty from other signs. Moreover, notwithstanding the opinion of Skoda to the contrary, it has a positive significance, indicating certainly in the vast majority of the cases in which it is observed, a special pathological condition, viz., a certain amount of liquid effusion between the pleural surfaces. Nevertheless, as stated at the outset, in view of the infrequency of its occurrence in connection with the pathological condition which it represents when it does occur, its brief duration, and, in general, the sufficiency of other physical signs denoting pleuritic effusion, its clinical value is comparatively small, and it might, without much detriment to physical diagnosis, be dropped from the catalogue of signs. It is to be classed among the curiosities of physical exploration, rather than among the phenomena possessing much practical importance.

In connection with the phenomena incident to the voice may be mentioned a novel method of exploration proposed by M. Hourmann, in which the auscultator observes the effect of his own voice on the chest of the patient. With the ear placed in apposition to the chest, but not pressed too firmly against it, more or less resonance and vibration are perceived, when words are pronounced with a loud voice, and in a manner to secure reverberation through the nasal passages. To this method M. Hourmann applies the title *autophonia*.[1] Whatever clinical value attaches to autophonic phenomena, of course depends on certain modifications representing certain morbid conditions. It is alleged that when the density of the lung is abnormally increased, the resonance and vibration communicated to the thoracic walls are proportionally exaggerated, and hence a disparity between the two sides of the chest in this respect belongs among the signs of solidification from pneumonia, crude tubercle, etc. Barth and Roger state, as the results of a series of clinical observations made with a view to determine the value of this method, that in about one-half of the instances in which solidification existed, either from the presence of tubercle or inflammatory exudation, the autophonic phenomena were more marked; in the other half no appreciable difference existing between the healthy and diseased sides; and that, in general, in the cases in which a disparity was apparent, it was slight in degree, being sometimes not appreciable without the closest comparison. In no instance did the sound present any special character which might indicate something more than the fact of increased density of the lung. The information to be derived from this method, therefore corresponds to bronchophony; and it may be occasionally useful when the voice of the patient is lost. Except in cases of aphonia it seems hardly deserving of attention, and, under any circumstances, its value consists in the confirmation which it may afford of other auscultatory signs far more reliable.

Summary of Facts Pertaining to Vocal Signs.—The normal thoracic vocal resonance in connection with certain morbid conditions may be increased or diminished, and may also present abnormal phenomena as regards quality, pitch, etc., of sound. The various deviations from health are arranged in four divisions, viz., exaggerated vocal resonance and bronchophony; diminished and suppressed vocal resonance; pectoriloquy, including amphoric voice, and ægophony. In exaggerated vocal resonance, the diffused, dull, distant resounding of the voice, accompanied with more or less vibration or thrill, which constitute the characters of the normal vocal resonance, are increased in intensity, without any notable alteration in other respects. In bronchophony there is, in addition, an abnormal concentration and clearness of the vocal sound, the voice seeming to be near the ear. The vocal resonance may be slightly, moderately, considerably, or greatly exaggerated. Bronchophony, also, in different morbid conditions, may be more or less marked. If slightly or moderately marked it is called weak, and if it have considerable or great intensity, it is called strong bronchophony. Strong bronchophony may exceed in intensity the sound heard over the trachea or larynx. The pitch of sound is not always the same as that of the tracheal or laryngeal voice. The vibration or thrill which generally accompanies exaggerated resonance, does not necessarily increase in proportion to the abnormal strength of the bronchophonic voice. Exaggerated vocal resonance habitually exists on the right, contrasted with the left side of the chest, and the thoracic voice at the summit of the right chest, in front, may even be bronchophonic without denoting disease. Exaggerated vocal resonance and bronchophony represent almost invariably morbid conditions, accompanied by increased density of lung. They occur in connection with the same conditions which give rise to the broncho-vesicular, and the bronchial respiration. They are generally marked in the second stage of pneumonitis, and it is in that disease especially that strong bronchophony is observed. Situated at the summit of the chest on one side within a circumscribed area, making due allowance for a normal degree of disparity, if the comparatively greater intensity be on the left side, they are valuable signs of a tuberculous deposit. Increased density of lung from compression, in cases of pleurisy with liquid effusion, may give rise to exaggerated resonance, situated over a part of the chest corresponding to the space occupied by the condensed pulmonary structure; and this situation, save in some exceptional instances, will be at the superior part of the chest. If strongly marked bronchophony exists under these circumstances, there is reason to suspect that the density of lung involves something more than compression, viz., solidification, either from inflammation or crude tubercle. Exaggerated vocal resonance may also, in connection with other signs, together with symptoms, denote carcinoma of the lung, melanotic deposit, extravasated blood or apoplexy, gangrene, serous infiltration, or extra-pulmonic morbid growths. It is rare that well-marked bronchophony exists in connection with these several affections. As an exception to the rule that exaggerated vocal resonance and bronchophony denote increased density of lung, both have been observed in cases of emphysema. Their occurrence, however, in the latter affection is altogether exceptional, the normal resonance, as a general rule, being diminished. Dilatation of the bronchiæ, accompanied with surrounding solidification, furnishes conditions calculated to give rise to strongly marked bronchophony. Incidental to bronchophony, especially when words are whispered, a *souffle* or blowing sound, more or less intense, and high in pitch, is a highly distinctive sign of solidification. It is analogous to the bronchial respiration, and is marked in some cases of solidification in which the latter is obscure or absent.

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[1] From αὐτὸς and φωνέω.

Diminution and suppression of the normal vocal resonance are incident to the rarefaction of the lung which obtains in emphysema; to obstruction of one of the large bronchi; to liquid effusion, and the presence of air within the pleural sac; to cavities filled with liquid; and, exceptionally, to some instances of solidification of lung.

Pectoriloquy is the transmission, more or less completely, of articulate words through the chest to the ear of the auscultator. This sign may be present, when various circumstances favorable to its production concur, in cases of pulmonary cavities; but it is by no means a sign distinctive of an excavation, as was held by Laennec. It is sometimes well marked in cases of solidification of the lung, in the second stage of pneumonitis, and from crude tubercle. When due to a tuberculous cavity, the space in which it is heard is circumscribed, situated, in the vast majority of cases, at the summit of the chest, and it is associated with the cavernous respiration and rales. In connection with pulmonary cavities arising from abscess or circumscribed gangrene it is seldom present, the several circumstances necessary for its production rarely concurring. It is rarely heard, even when tuberculous cavities exist, the various incidental conditions upon which it depends, being either permanently wanting, or only transiently present. A cavernous voice sometimes has a ringing, metallic tone, resembling the sound produced by speaking into an empty vase. It is then called amphoric. This modification is noticed, for the sake of convenience, as an event incidental to pectoriloquy, but it may or may not coexist with transmission of speech. Strictly, it is a sign distinct from pectoriloquy, and is more significant of a cavity than the latter. The transmission of articulated words, or pectoriloquy, does not sustain any fixed relation to the amount of thoracic resonance, or to the strength of the oral voice. It may be strongly marked, when the voice is feeble and even extinguished. Whispering pectoriloquy, however, may accompany solidification of lung, as well as an excavation. An amphoric vocal sound is more apt to occur in a pleural cavity, in pneumo-hydrothorax, than in tuberculous excavations. Ordinary pectoriloquy may be present in the affection just mentioned. It may also be well-marked in pouch-like dilatation of the bronchiæ, a lesion of very rare occurrence.

Ægophony is characterized by a peculiar tremulousness, together with acuteness of the thoracic voice. These characters are sometimes due to peculiarities of the oral voice, and care is necessary to avoid attributing them to morbid conditions under these circumstances. Morbid ægophony may be strongly marked, or the thoracic voice may be slightly ægophonic, and the abnormal modifications may have every shade of gradation between these extremes. It is most apt to be heard at or near the lower angle of the scapula, and if it extend from this point, it is generally found within a narrow zone following the direction of the ribs toward the nipple. It may, however, be heard at any part of the chest, and is sometimes diffused over the whole side. It occurs when a small or moderate amount of liquid effusion is contained within the pleural sac. It is therefore incident to pleurisy, hydrothorax, and occasionally to empyema and pneumonitis. If it be sometimes observed in connection with solidification, without liquid effusion, as held by some, these instances are rare exceptions to the general rule.

In the vast proportion of the instances in which it is observed, it is incident to simple pleurisy; but is seldom discovered even in that affection, owing to the precise amount of liquid requisite for its production existing only in certain cases, and in these only for a brief period. When discoverable it is usually at an early period after the attack, or late in the progress of the disease. Occurring in connection with pneumonitis, it has been observed to disappear from the lower scapular region when the body is inclined far forward, and to be replaced by bronchophony. Although very rarely well marked in cases of pneumonitis, it is not uncommon for the bronchophonic voice, in that affection, to present slight tremulousness, with elevation of pitch, in other words to manifest an approximation to ægophony. In cases of pleurisy the sign has been observed to shift its seat in the progress of the disease, following the increase, on the one hand, and the diminution on the other hand, of the quantity of liquid effusion.

PHENOMENA INCIDENT TO THE ACT OF COUGHING.

Tussive phenomena possess comparatively small importance, inasmuch as the information which they afford is, in general, obtained more satisfactorily, and with greater facility, by auscultation of the respiration and voice. Nevertheless, the signs pertaining to cough are by no means undeserving of attention, and in some instances they are valuable auxiliaries in diagnosis. A voluntary act of coughing is often useful incidentally with reference to other signs. Sometimes, when from nervous agitation, or awkwardness, a patient breathes unnaturally and fails to comply with the directions to increase the intensity of the respiration, if requested to cough, he involuntarily takes a deep inspiration preparatory to the act, and at this moment the respiratory murmur may be well developed, when before it was hardly appreciable. In this way a crepitant rale may perhaps be evolved, not otherwise perceptible. By an act of coughing an obstruction seated in some of the bronchial tubes may be removed, and the respiratory murmur reproduced in parts of the chest in which it had been temporarily suspended. The cause of the absence of the respiration is thus determined. Instances occasionally occur in which it is difficult to decide from the characters pertaining to the sound whether a rale emanates from the bronchiæ or pleura. In such a case if it be found to disappear or undergo a material modification after coughing, it is bronchial, but if it remain unaffected it is likely to be pleural.

The tussive sounds incident to health have been briefly described. Those heard over the chest undergo certain modifications in consequence of intra-thoracic disease, and certain adventitious sounds may also be produced by coughing. Both species of signs, *i. e.* modified natural sounds, and new sounds, are few in number compared with those derived from respiration and the voice; moreover, each of the tussive signs will be found to have its analogue among those incident to respiration.

All the phenomena incident to the act of coughing which are practically important, may be arranged into two classes, viz., 1. Bronchial Cough; 2. Cavernous Cough.

1. **Bronchial Cough.**—The tussive sound is bronchial, or, as it is also termed, tubular, when, in place of the feeble, short, diffused sound, unaccompanied by much, if any, impulse or shock, constituting the tussive phenomena heard over the chest in health, the ear receives,

a concussion more or less forcible, together with a blowing sound more or less intense, prolonged, concentrated, elevated in pitch, conveying the impression of nearness. These characters are similar to those which belong to the phenomena produced normally within the trachea by the act of coughing. The analogue of the bronchial or tubular cough is the bronchial respiration, and it is usually associated with exaggerated vocal resonance or bronchophony. The characters which have just been mentioned are in fact identical with those which belong to the expiratory sound in the bronchial respiration. They may be strongly marked in some cases in which the bronchial respiration is feeble, and hence the tussive sign may be valuable, not only as confirming, but as a substitute for the latter. It represents precisely the same physical conditions as the bronchial respiration and bronchophony. The bronchial cough, therefore, occurs especially in the second stage of pneumonitis; next in frequency and prominence, in connection with crude tubercle; also in pleurisy over the lung rendered dense by compression, in apoplectic extravasation, œdema and dilatation of the bronchial tubes, etc. The mechanism of its production involves the same physical principles as the bronchial expiratory sound. It originates within the trachea and bronchial tubes; the column of air therein contained being expelled with force by the violent and quick expiration, the vocal chords at the same time approximated, and the blowing sound transmitted with greater intensity to the ear of the auscultator in consequence of the density of the intervening pulmonary structure.

2. Cavernous Cough.—The cavernous cough embraces three distinct varieties. The first occurs when a pulmonary cavity is empty, *i. e.* free from liquid contents. Under these circumstances the act of coughing gives rise to a shock, often much more marked than in bronchial cough. The head of the auscultator seems sometimes to be raised by the force of the impulse. It is accompanied by a blowing sound more or less intense and prolonged, probably always lower in pitch than the expiratory sound in the bronchial respiration, or the souffle accompanying whispered words; and conveying the impression of its being produced within a hollow space. These characters, contrasted with those belonging to the bronchial cough, are distinctive; but the discrimination involves, in addition, the fact that they are found within circumscribed limits; and, inasmuch as in nine cases in ten pulmonary excavations are due to tuberculous dis-

ease, they are almost invariably situated at the summit of the chest, in the infra-clavicular region. These two points, viz., the limited area and the locality, will serve to distinguish a cavernous from a bronchial blowing, taken in connection with the intrinsic differences in the characters of the two sounds. The pathological significance of this variety of cavernous cough is, of course, the same as that of simple cavernous respiration: the latter is its analogue. The one may be well marked, when the other is not distinctly appreciable. A cavernous blowing produced by the act of coughing may, therefore, sometimes be available, when with ordinary respiration it is not readily discovered. If both are present, they serve mutually to confirm each other. The mechanism, it is obvious, is the same in either instance. The circumstances which are favorable to the presence of both are identical, viz., in addition to emptiness of the cavity, its size, communication with the bronchial tubes, the latter being unobstructed, superficial situation, etc.

The second variety is *amphoric cough.* A cavernous cough becomes amphoric when it has a ringing, metallic tone, resembling that which constitutes a variety of the respiratory and vocal sounds to which the same title is applied. An amphoric cough may be imitated by coughing over the mouth of an empty vase. It occurs under the circumstances which give rise to amphoric voice, viz., in connection with a pulmonary cavity of large size, with rigid walls, or with pneumo-hydrothorax involving perforation. The significance and the mechanism are in all respects the same.

The third variety is an adventitious sound produced when the cavity is partially filled with liquid. The analogue of this kind of cavernous cough is the gurgling rale accompanying respiration. Under the conditions which are necessary for the production of gurgling, the liquid contained within the cavity is more violently agitated by the movements involved in coughing, and a loud splashing sound is frequently produced. This sound, well marked, is more readily than gurgling distinguished from the bronchial mucous rales, and if situated at the summit of the chest, within a circumscribed area, it is the most significant of the physical signs denoting a tuberculous cavity of considerable size. It will be likely to alternate with the dry variety of cavernous cough, with cavernous respiration, possibly also with pectoriloquy; and to coexist with gurgling; but it may be present when none of the cavernous signs just mentioned are distinctly marked.

frequently being continued into the expiration. Sometimes when it is not heard with ordinary breathing, it becomes developed by a forced inspiration. It rarely accompanies each successive act of respiration, but is heard at irregular intervals. It is important to bear in mind the fact that it may be found in connection with the voice and cough when it does not attend the respiration; and that it may be produced by coughing, when it is not observed either with the voice or respiration. Its situation is commonly at the middle third of the chest, anteriorly, posteriorly, or laterally. It is sometimes confined to a circumscribed space at the summit. In other instances it is diffused over the entire chest on one side. In the progress of the same disease it may be found to shift its seat, being heard at first over the middle of the chest, and afterward at a higher point. Its duration in different cases differs. It may be transient, or persist for a long time. In constancy it is also variable. Sometimes it appears, ceases for a time, and is again reproduced; or, it comes and goes at irregular intervals. The sound in some instances appears to be near the ear, and in other instances more or less remote. Finally, in sharpness and quality of tone, as well as intensity, there are variations which are clinically unimportant. For the most part the differences just mentioned are explicable by reference to varying circumstances connected with the physical conditions upon which the sign is dependent.

In determining the presence of this sign, there is scarcely a possibility of confounding it with any other of the auscultatory phenomena. The only liability to error arises from the fact that a metallic tinkling sound, as already intimated, is occasionally produced within the stomach, and transmitted, so as to be apparent on auscultating the inferior portion of the left chest. Mere gastric tinklings, however, are never so frequently repeated or persisting as are generally those produced within the chest. They occur irrespective of either respiration, voice, or cough, and this alone suffices for the discrimination. Moreover, the associated signs and symptoms will always show the absence of the intra-thoracic affections to which it is incident when produced within the chest.

The physical conditions involved in the production of metallic tinkling are sufficiently established. It requires the existence of a cavity of considerable size, containing a certain quantity of liquid, the remainder of the space being filled with air or gas. Skoda contends that the presence of liquid is not essential—an opinion he is in a [illegible] almost [illegible] the presence of [illegible] at the middle third or [illegible]. But dependence on this [illegible] necessary, the concomitant signs [illegible], being quite distinctive, as has appeared from the phenomena incident to percussion and auscultation, which have been already considered.

[illegible] Forbes's Translation, Edition of 1830, pages 526 and

Although the physical conditions giving rise to this sign are so well understood, and its pathological significance so precise and well-defined, the mechanism of its production has been the subject of much discussion and diversity of opinion. We have here, however, another exemplification of the fact, that the clinical value of physical signs is not dependent on our ability to adduce all the physical principles which their production involves. Different writers may differ widely as respects the latter, but there is very little room for discrepancy of opinion concerning the pathological or anatomical relations of metallic tinkling. To discuss the various hypotheses which have been offered in explanation of the sign, would require more space than the importance of the subject, in a practical point of view, merits, and I shall therefore restrict myself to a brief notice of those which appear to be sustained by observation and experiment. Laennec attributed its production, in certain instances, to drops of fluid falling from the upper part of the space, upon the surface of the liquid below. He offers this explanation in the cases in which the sound is observed to follow change from the recumbent to a sitting posture, and implies that it is not intended to apply to all other instances, but without giving any special rationale. That the falling of drops of liquid upon a quantity of liquid within a cavity, will give rise to a tinkling sound, he demonstrated by injecting, in small quantities at a time, a fluid into the chest of a patient with empyema after the operation of paracentesis. An imitation of the sound takes place, when drops of liquid are made to fall into a vessel one-third full of water. Another explanation, suggested by Dr. Spittal, of Edinburgh, in 1830, and demonstrated by experiments reported by Dr. Jacob Bigelow, of Boston,[1] Dance, Fournet, and Barth and Roger, in France,[2] is, that the air, finding its way through a fistulous orifice opening below the level of the liquid, rises to the surface of the latter, forming bubbles, which break and give rise to a tinkling sound. The experiments by Dr. Bigelow were made on the bodies of subjects dead with pneumo-hydrothorax, and with a recent bladder or stomach partially filled with liquid. When a catheter was introduced through an opening into the chest, and carried below the surface of the liquid, air blown through the instrument produced an exquisite metallic tinkling at the explosion of each bubble, resembling the sound heard during life. This result obtained only when a few ounces of liquid were contained within the chest. If the quantity was increased by injection to the amount of two or more quarts, a bubbling sound was alone produced. Tinkling also was produced by repeating Laennec's experiment, viz., letting fall drops of water from above upon the liquid in the chest. A bladder, and afterward a stomach, each containing a few ounces of water, and then inflated until thoroughly distended, were used to produce an imitation of the characteristic sound by a similar method.[1] "Whenever the inflating tube was pushed below the surface of the liquid, and the inflation continued so as to produce bubbles, a sharp tinkling was heard upon the explosion of every bubble by the ear applied, as in auscultating, to the outside of the bladder. In this experiment, the sound becomes more exquisitely metallic, in proportion as the tension of the bladder is increased by farther inflation." Fournet produced similar results by injecting, during life, in a patient on whom had been performed the operation of paracentesis, air through a female catheter carried below the level of the liquid. This experiment was repeated several times.[2] Barth and Roger, on repeating the experiments made by Dr. Bigelow with a bladder, found the same results.[3] This explanation, it is obvious, will only apply to the instances in which a communication exists between the cavity and the bronchial tubes, or externally by means of an opening through the thoracic walls. It is difficult also to understand the persistency of the sign when thus produced, since the accumulation of air above the level of the liquid must soon establish an equilibrium of pressure between it and the external atmosphere, so that bubbles would no longer rise and explode in the manner described. Simple agitation of the liquid, is competent to give rise to the sound. This is proved by succussion of the body of patients with pneumo-hydrothorax, both during life and after death.[4] A sufficient amount of agitation, it may be imagined, takes place with respiration, but more especially with the acts of speaking and coughing. Again, experiments appear to show that the bursting of bubbles of mucus at the opening of a fistulous orifice situated above the level of the liquid, may occasion a sound resembling, but not absolutely identical with metallic tinkling.[5] Without citing other explanations, less satisfactorily established, the mechanism of the sign probably involves the several modes just mentioned, alternating with each other, or more or less combined together.[1] Either explanation, taken singly, is met by objections derived from instances in which the sign is observed to take place; but collectively, they render its production intelligible, under the different circumstances pertaining to the physical conditions upon which it depends. Adopting this view of the subject, a frequent, perhaps the most frequent cause of the phenomenon, is the explosion of bubbles of air on the surface of the liquid. In the rare instances in which no communication exists between the pleural cavity and the bronchial tubes, it is probably due to the agitation of the liquid, portions being thrown upward and falling back upon the surface. Under these circumstances, the sign will not be likely to accompany respiration, but only the voice and coughing, possibly being confined to the latter act. In this mode it is produced by change of position, or movements of the body. It is not difficult to conceive that the flocculent false membranes at the superior part of the space, may retain a small quantity of the liquid for a short period, after rising from the horizontal to the upright posture, which falls in drops, as supposed by Laennec. If there be fistulous communication with the bronchiæ, and the opening be above the level of the liquid, the sound is probably owing to the bursting of bubbles at the orifice opening into the cavity. Different modes of the production of metallic tinkling may be conjoined, *i. e.* may operate in combination. Thus the sounds due to explosive bubbles and agitation of the liquid may occur simultaneously. It is also easy to understand that they may succeed each other in alternation. For instance, the orifice may at one time be above, and at another time below, the level of the liquid, owing to variations in the proportionate quantity of the latter. The orifice, also, or the bronchial tubes leading thereto, may at times be obstructed, and at other times pervious; an aperture may at one period of the disease exist, and afterward become permanently closed. These varying circumstances will serve to explain the variations in quality, intensity, situation, duration, persistency, etc., which have been seen to enter into the description of metallic tinkling.

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[1] Vide American Journal of Med. Sciences, 1839, and a recent volume by Dr. Bigelow, entitled Nature in Disease, etc.

[2] Vide Treatises by Barth and Roger, French edition of 1854, and by Fournet.

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[1] The bladder or stomach employed in these experiments should be recent.

[2] Op. cit. t. 1, page 378, et seq.

[3] Op. cit, ed. of 1854, page 239.

[4] Vide Dr. Bigelow's experiments, op. cit.

[5] Vide experiments by Bigelow, Fournet, and Barth and Roger.

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[1] The reader who may desire a fuller account of the experimental researches which have been made in order to elucidate the mechanism of the production of metallic tinkling, will find them detailed at length by the several authors referred to. I have deemed it inconsistent with the practical objects of this work to yield the space which their introduction at length would require. Skoda attempts to account for the sign by his favorite theory of consonance, but its application in this instance is even less satisfactory than to the explanation of other auscultatory phenomena.

Metallic tinkling is frequently associated with amphoric respiration, voice, and cough, and by some writers it is regarded as essentially similar to the three signs last mentioned.[1] The pathological and diagnostic relations are the same. As respects the audible characters, however, an analogy only exists; there is by no means an identity. Moreover, different physical conditions are involved, certainly in the great majority of instances. Metallic tinkling, with very few exceptions, occurs in cavities containing at the same time air and liquid. It is, indeed, possible that in one of the modes by which it is supposed to be produced, viz., by bubbles exploding at the opening of a fistulous communication, the presence of liquid within the cavity is not indispensable; but a fistulous communication, either with a pulmonary excavation or the pleural cavity, more especially with the latter, very rarely exists without the presence of more or less liquid; and, moreover, in the case just instanced, a mucous liquid is required for the formation of the bubbles, which explode at the point of communication. Amphoric respiration, cough, and voice, on the other hand, it is supposed, may occur in connection with empty cavities without bronchial communication, provided a thin septum only intervene between the space and a large bronchia. And, when, as is generally the case, a communication exists, and liquid is present in the cavity, the latter does not take part in the production of amphoric respiration, voice, and cough; while, certainly in the large proportion of instances, the liquid plays an important rôle in the production of metallic tinkling. Amphoric respiration, voice, and cough, demand only a space of considerable size filled with air. Metallic tinkling, occasioned, as has been seen, generally by bubbles rising to the surface of a liquid, or by drops of liquid falling, or by agitation of a mass of liquid, cannot take place, save in the exceptional mode mentioned, in a cavity containing nothing but air. These statements are shown to be correct by facts detailed in connection with the experiments by Bigelow and others, to which reference has just been made. In subjects dead with pneumo-hydrothorax, or patients on whom had been practised the operation of paracentesis, and with a recent bladder or stomach partially filled with liquid, whenever air was blown through a tube, introduced into the cavity and carried above the level of the liquid, a sound analogous to the amphoric respiration was heard on applying the ear to the chest, or to the distended membrane; and never the metallic tinkling, excepting saliva was carried into the tube, producing bubbles at its extremity. Although, therefore, this sign is so often associated with the amphoric modifications of respiration, voice, and cough, the phenomena cannot be properly considered as essentially the same.

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[1] Walshe, Skoda.

SUMMARY.

Metallic tinkling requires, as a general rule, with perhaps some rare exceptions, a cavity of considerable size containing air and a certain quantity of liquid. In the vast proportion of cases the cavity in which it occurs communicates with the bronchial tubes. It is occasionally produced within tuberculous excavations, but occurs in a large proportion of cases of pneumo-hydrothorax. It is almost pathognomonic of the latter affection, and is found frequently to coexist or alternate with amphoric respiration, voice, and cough.

ABNORMAL TRANSMISSION OF THE SOUNDS OF THE HEART.

In auscultating the chest in health, the sounds of the heart may be heard in all directions, at a distance more or less remote from the præcordial region, the extent of their diffusion and their intensity differing considerably in different persons. Provided the intrathoracic organs are free from disease, it may be assumed that the loudness of the heart-sounds is proportionate to the proximity to the heart; and they will be found to diminish gradually, as the ear is removed from the præcordia, until, at length, they cease to be appreciable. If, therefore, they are discovered to be more intense at a certain distance, than at any intermediate point, it shows that a morbid condition exists, in consequence of which they are abnormally transmitted. For example, if the sounds are heard with greater distinctness and force just below the left clavicle, than at any point between this situation and the præcordia, it follows that there is an abnormal transmission to the part designated. Again, if the sounds have greater intensity in the right than the left infra-clavicular region, the former being considerably farther removed from their source, it is due to a morbid condition. Abnormal transmission of the sounds of the heart may thus become a sign of disease. It is [illegible] a mass of tuberculous [illegible] furnishes strong presumptive evidence [illegible] phthisis ; and it is [illegible] in connection with the various other signs [illegible] affection. [illegible] significance of [illegible] circumscribed area at the [illegible]

In consolidation from pneumonia, and in cases of liquid effusion within the pleural sac, the sounds of the heart are unduly audible. In connection with these affections the abnormal transmission extends over a much larger space than in the cases of tuberculosis in which the sign occurs. In the diagnosis of these affections its value is insignificant, other signs being abundant and positive.

Observed within a more limited space, but not confined to the superior portion of the chest, this sign may coexist with others of much greater reliability, denoting solidification from extravasated blood, carcinoma, etc.

An abnormal diminution, as well as increase of the transmitted heart-sounds, may constitute a physical sign of disease. Emphysema lessens the conducting power of the lung, and as one of the results of this affection, the sounds may be found to have greater intensity at certain distance from the præcordia, than at another situation less remote. Dr. Walshe states that in a case of intense emphysema of the left lung in which the disease was limited, and especially marked at the posterior aspect of the chest, he found the heart-sounds considerably more distinct posteriorly on the right than on the left side, there being no evidence of induration of the right lung to intensify the sounds on that side. The disparity here was attributed to an abnormal diminution of the transmission of the sounds to the posterior surface of the left chest, the right side remaining in a normal condition in this respect. Without knowledge of the fact that the transmission may thus be abnormally diminished, a normal intensity may be mistaken for a morbid sign.

Abnormal feebleness of the sounds of the heart in the præcordial region is an effect of emphysema affecting the left lung. The enlargement of the lung from the over-distension of the cells causes it to extend over the whole of the surface of the heart, instead of the latter organ being in contact with the walls of the chest within a certain space. Under these circumstances it is easy to perceive that the sounds of the heart must be transmitted to the ear applied over the præcordia with less intensity than in a normal condition. Abnormal diminution of the sounds of the heart in the præcordia, in connection with undue clearness of the percussion resonance, and absence of the heart's impulse, denotes that a thick layer of lung intervenes between the organ and the thoracic parietes.

The cardiac sounds may not only be transmitted with undue intensity to different portions of the chest, but they may emanate from other situations than the præcordia, in consequence of displacement of the heart. This will be found to enter into the history of pleurisy with large liquid effusion, and of pneumo-hydrothorax. Finally, a bellows arterial sound is sometimes heard within a circumscribed space at the summit of the chest on one side, not transmitted from the heart, but limited to the subclavian artery, probably produced by pressure upon the artery, of the apex of the lung consolidated by tuberculous deposit. Dr. Stokes was the first to call attention to the occasional occurrence of this, as a physical sign of phthisis. He thinks that sympathetic irritation of the artery is sufficient to occasion it without pressure, basing this opinion on its intermittency, and his having observed it to subside after copious hæmoptysis, and leeching in the subclavian or axillary regions.[1] Whatever may be the explanation, the occasional occurrence of a *bruit de soufflet*, in connection with a tuberculous deposit of the apex of the lung, the sound being wanting in the brachial artery of the same side, in the heart, aorta, and carotid, and in the opposite subclavian, is a fact important to be borne in mind.

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[1] Stokes on the Chest, American edition, 1844, page 385.

History.

Although allusion to listening in order to discover abnormal sounds within the chest may be found in the works of various writers even as ancient as those of Hippocrates, yet to so little extent was this method of investigation previously employed, and so insignificant had been its results, that the honor of the discovery justly belongs to Réné Théophile Hyacinthe Laennec, a native of Lower Brittany, born in 1781. The discovery was made by Laennec, while acting as chief physician to the Hospital Necker, in Paris, in 1816. It was communicated to the French Academy of Sciences in a memoir read in 1818, and during the same year was published the great work entitled "*De l'Auscultation Mediate, ou Traité du diagnostic des Maladies des Poumons et du Cœur, fondé principalement sur ce nouveau moyen d'exploration.*" In the introduction to this work, Laennec announces the discovery, and relates the circumstance which led to it in the following words: "In 1816, I was consulted by a young woman laboring under general symptoms of diseased heart, and in whose case percussion and the application of the hand were of little avail on account of the great degree of fatness. The other method just mentioned being rendered inadmissible by the age and sex of the patient, I happened to recollect a simple and well-known fact in acoustics, and fancied, at the same time, that it might be turned to some use on the present occasion. The fact I allude to is the augmented impression of sound when conveyed through certain solid bodies—as when we hear the scratch of a pin at one end of a piece of wood, on applying one ear to the other. Immediately, on this suggestion, I rolled a quire of paper into a kind of cylinder, and applied one end of it to the region of the heart and the other to my ear, and was not a little surprised and pleased to find that I could thereby perceive the action of the heart in a manner much more clear and distinct than I had ever been able to do by the immediate application of the ear. From this moment I imagined that the circumstance might furnish means for enabling us to ascertain the character, not only of the action of the heart, but of every species of sound produced by the motion of all the thoracic viscera, and, consequently, for the exploration of the respiration, the voice, the *rale* or *rhonchus*, and perhaps even the fluctuation of fluid effused in the pleura or pericardium. With this conviction I forthwith commenced at the Hospital Necker a series of observations which have continued to the present time. The consequence is, that I have been enabled to discover a set of new signs of disease of the chest, for the most part certain, simple, and prominent, and calculated, perhaps, to render the diagnosis of the diseases of the lungs, heart, and pleura, as decided and circumstantial as the indications furnished to the surgeon by the introduction of the finger or sound, in the complaints wherein these are used."[1]

It is a curious fact, that the suggestion which led to the discovery was an error in physics. The sound, in the illustration cited in the foregoing paragraph, is not augmented, but merely conducted vastly better than through the atmosphere; and it is now well established that intra-thoracic sounds are heard with the ear applied directly to the chest, as well as, if not better, than through the intervening medium, or stethoscope, to which Laennec attached so much importance as to call the new method by the title of *mediate* auscultation.

In the remarkable work, the title of which has been given, the various phenomena revealed by auscultation are named, described, classified, explained, and their relations to morbid conditions determined with a degree of completeness and accuracy, constituting it an imperishable monument of the industry and genius of the author. To such an extent was the science of auscultation perfected in the hands of its founder, that a considerable portion remains to the present moment unchanged, notwithstanding the labors of a host of observers, who have striven to enlarge the boundaries of its application to the diagnosis of diseases. Rarely, if ever, has there been an instance of a discovery of equal importance in which so little was left by the discoverer to be performed by others. Moreover, as an exception to the general rule, the gratification was accorded to Laennec of witnessing the acknowledgment of the value of his discovery, and its adoption by the most intelligent of his contemporaries. Nevertheless, the labors of those who have devoted attention to the cultivation of this department of medical science, since the discovery by Laennec, have by no means been without useful results. Some errors have been corrected, auscultatory phenomena have been studied in new aspects, important parts have been added, and, in short, the physical diagnosis of thoracic affection has been rendered more easy and precise by contributions to our knowledge from various persons, many mentioned in the foregoing pages in connection with the particular services with which their names are identified.

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[1] Forbes' translation.

Laennec died in 1826, of tuberculous disease of the lungs, in the forty-fifth year of his age.

CHAPTER IV.

INSPECTION.

Physical exploration, by means of inspection, consists in an ocular examination of the chest, in order to discover deviations from symmetry, or any abnormal appearances, as regards size and form, and also visible alterations of the natural movements incident to respiration. Important physical signs are determined by this method. In the relative value of the phenomena which it furnishes, it ranks next to auscultation and percussion. In the practice of physical exploration, this method should generally be first employed, because its results are to be taken into account in estimating the importance which belongs to the phenomena obtained by the methods which have been already considered.

Whenever a careful inspection is necessary, it is most convenient and satisfactory to survey the chest divested of all clothing. This may be done with propriety if the patient be of the male sex; but a due regard to delicacy requires that the entire chest of the female shall not be uncovered. To secure the advantages of a complete examination without offence to modesty, different sections may be inspected separately. The lower portion of the chest anteriorly, including the mamma, may be covered, while the upper part is exposed; and afterward the upper part, with the mamma, covered, while the lower portion is denuded.

This will suffice for all the purposes of exploration, without insisting on an exhibition of the mammary region. The examination may be made while the patient is recumbent, or sitting, or standing. When circumstances render it practicable and proper, the last-mentioned position or the second is preferable to the first. Sitting or standing, the patient should be placed opposite a good light, and requested not to incline the body in either direction; the attitude should be perfectly easy, the muscles relaxed, the upper extremities hanging loosely by the side, while the practitioner first surveys the chest at a suitable distance directly in front, and afterwards on each side, obtaining a view in profile. The anterior and posterior surfaces of the chest are to be inspected, observing the same precautions. The examination of the posterior surface, especially, is most conveniently made when the patient stands. If the recumbent attitude be necessary, on account of the feebleness of the patient, or other causes, care is to be observed that the body rests on an even plane. Inattention to this point may affect materially the results of the examination.

In the size, configuration, &c., of the chest, considerable differences are observed in different persons free from thoracic disease. It is impossible to fix upon a normal standard, which shall serve as a criterion by which to estimate either the existence or the degree of abnormal deviations. The physical signs furnished by inspection, as a general rule, are determined by observing a want of correspondence between the two sides. Taking advantage of the fact that for the most part, intra-thoracic diseases are either confined to one side, or affect one side more than the other, and assuming that in a normal condition the two sides are symmetrical (which, with certain exceptions, observation shows to be correct), a marked disparity in the visible appearances is fairly presumed to be the effect of disease. Moreover, observation teaches that diseases tend to produce different effects upon the size, form, and movements of the chest, and that different affections, individually, are characterized by their own special alterations. Hence, the source of the significance of the latter as physical signs. Their value, as indices, of certain physical conditions, rests on the constancy of their connection with these conditions.

Most of the facts which would fall under the head of *inspection in health* have already been stated in the introduction to this work. It is important to take cognizance of certain variations from the rule of perfect symmetry of the two sides, occurring very frequently not only in health, but without spinal curvature, or any other deformity. In some persons the size of the right side at the middle and lower portions is obviously somewhat greater than that of the left. Generally, however, to determine the disparity which exists in this region, mensuration is requisite. The direction of the ribs on the right side is a little less oblique than on the left side. M. Woillez[1] found, of 1[illegible] subjects in good health, and without spinal curvature, that in 47 only was the symmetry in all respects absolutely perfect. A projection of the left side in front, either at, or above, or below the nipple, existed in the proportion of 26 per cent. An anterior projection on the right side existed only in two instances. Hence, if a projection be observed on the right side, the probabilities of its being pathological are much greater than if it be on the left side. On the other hand, a posterior projection on the right side is very frequently observed, existing in 29 per cent. of the subjects examined by M. Woillez, while it is very rarely noticed on the left side. Variations, due to slight spinal curvature, are exceedingly common. The majority of persons, especially laborers and mechanics, are not altogether exempt from disturbance of symmetry due to this cause. The inclination is commonly to the right, causing depression of the shoulder, and approximation of the ribs on that side. Slight curvature of the spine is also very common with females. Want of harmony between the two sides, not sufficiently marked to be observed without careful examination, may occasion an appreciable disparity as respects the signs furnished by percussion and auscultation, and, hence, the importance of first comparing closely by inspection wherever it is important to institute a close comparison by means of the other methods of exploration. It is especially with reference to the diagnosis, in certain cases of tuberculous disease, that slight deviations from symmetry, dependent on spinal curvature, or other causes, irrespective of existing disease, are to be taken into account. Alterations of size and configuration, when well marked, will, of course, not require for their discovery a close inspection. In such instances, the questions to be determined are, whether they are due to deformity, congenital or acquired, or injury of the thoracic walls; to intra-thoracic affections of an anterior date, more or less remote, which have left permanent effects on the conformation of the chest, or to present disease. The nature of the alterations, and the attendant circumstances, generally render it easy to decide in which of these categories abnormal appearances properly belong.

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[1] Op. cit.

The morbid appearances determined by inspection, which relate to present or pre-existing intra-thoracic disease, may be divided into those pertaining, *first*, to alterations of size and form, and *second*, to the respiratory movements.

1. Morbid Appearances pertaining to the Size and Form of the Chest.—The more important of these may be classified under two heads, viz., enlargement and contraction; each admitting of subdivision into general and partial. The enlargement or contraction is general when the dimensions of the whole of at least one side of the chest is either increased or diminished. Partial enlargement or contraction is

when there is either a projection or depression of a portion of the chest on one or both sides.

General enlargement of the chest occurs 1st, in consequence of augmented volume of the pulmonary organs, or 2d, from the accumulation of liquid, or air, or both, within the pleural sac. The enlargement from either of these causes, produces changes in the relations of the component parts of the chest analogous to those incident to a deep inspiration. The sternum and clavicles are elevated; the upper ribs converge; the lower ribs are more widely separated; and the abdominal space below the xiphoid cartilage, and between the false and floating ribs, is widened. It is generally practicable to determine by the appearances pertaining to the enlargement, on which of the two anatomical conditions just mentioned it is dependent, that is, whether it be owing to the augmented volume of the lung, or to the presence of liquid or air between the pleural surfaces.

The lungs are rendered abnormally voluminous by the retention of an undue quantity of air within the pulmonary cells, constituting emphysema. If both lungs are emphysematous, the chest remains expanded as it is by a deep inspiration. The enlargement, however, is usually most marked at the superior and middle portions of the chest; the reverse of this, as will be seen presently, obtaining when the enlargement is due to liquid in the cavity of the pleura. The reasons for the fact just stated are, first, emphysema affects most the upper lobe; and, second, the action of the diaphragm incident to the labored respiration occasioned by the disease, offers an obstacle to the enlargement of the inferior portion of the chest. The latter, indeed, may appear to be contracted, from the greater relative dilatation of the superior and middle portions. It is rarely the case, when the enlargement from emphysema is general, *i. e.* affecting more or less one chest at least, that the side is regularly dilated. The emphysema being usually more marked at some parts of the lung than at others, the surface of the chest presents a corresponding inequality. In this respect the enlargement from emphysema differs from that due to liquid in the pleural sac, the expansion in the latter being more regular. Moreover, the enlargement from emphysema is never so great as that not infrequently observed from pleural effusion. If the emphysema affect both lungs, the two sides of the chest will of course be enlarged. And if both lungs are equally augmented, it is difficult to determine to what extent the dimensions are increased, not having the advantage of a comparison of the two sides with respect to this point. It is, however, very rarely the case that emphysema does not affect one lung to a greater extent than the other; and observations show that the left lung is more prone to a greater relative amount of augmentation than the right.[1] Dilatation of the chest from emphysema is oftener limited than general, so that the anatomical condition constituting this affection will presently be cited as a cause of partial enlargement. General, but usually unequal enlargement of the chest, occurs in some cases of bronchitis, probably owing to dilatation of the air-cells, in fact to a temporary emphysematous condition. This obtains especially in bronchitis affecting the smaller bronchial tubes (capillary bronchitis); and it has been observed, in a marked degree, in the bronchitis complicating typhoid fever.[2] Supplementarily, the dimensions of the chest on one side become increased, when, from any cause, the functions of the lung on the other side are interrupted. Thus, a manifest enlargement of the healthy side occurs in chronic pleurisy, owing to the respiratory movements, and consequent inflation of the lung on that side, being increased to compensate for the partial or complete suspension of hæmatosis in the diseased side. Increased voluntary respiratory efforts systematically continued, effect a considerable augmentation of the volume of the lungs, as shown by the enlargement of the chest which follows the use of the tubes of late years in vogue for that purpose. Gymnastic, or other muscular exercise, involving an unusual activity of respiration, also produce the same result.

In simple pneumonitis affecting an entire lung, the chest on the affected side may be visibly enlarged. Generally, however, in cases of this disease, the inflammation being limited to a single lobe, the enlargement, if it be sufficient to be apparent, is confined to a portion of the chest. The augmented volume of the lung incident to this affection, is due not necessarily to pleural effusion, but to the deposit of solid matter within the air-cells, in consequence of which the volume of the lung is sensibly augmented.

It is in cases in which a large quantity of liquid, or air, or both, are contained in the pleural sac, that general enlargement of the chest occurs most frequently, and is most marked. Universal, and not infrequently great dilatation on one side, is an important physical sign in chronic pleurisy with abundant effusion, and in pneumo-hydrothorax. General enlargement in these affections is always confined to one side. An accumulation of liquid, or air, in both pleural cavities, sufficient to dilate the two sides, would be incompatible with life, since it would involve diminution of the volume of the lungs to an extent to render them nearly or quite useless. The enlargement is more regular than in cases of emphysema, but it is most manifest at the lower part of the chest, in this respect presenting a contrast with the enlargement from emphysema. The concomitant signs, however, especially in simple pleurisy, render the discrimination sufficiently easy. In emphysema, the percussion-resonance is never lost, and is generally abnormally clear, with a quality more or less approximating to the tympanitic. In pleurisy, with abundant liquid effusion, the percussion-sound is flat. In pneumo-hydrothorax, the difference, as regards the signs furnished by percussion, is less striking. The chest is highly resonant and tympanitic above the level of the liquid, flatness existing below that point; but with the aid of the auscultatory signs, viz., metallic tinkling and amphoric respiration, in connection with the symptoms and history, the differential diagnosis does not involve much difficulty. The expansion of the thoracic walls, if it be considerable, by the direct pressure of liquid or air, occasions other changes than those incident to simple enlargement, which have been mentioned. The direction of the lower ribs undergoes a change. They are less oblique. The intercostal depressions are effaced, and the integument between the ribs may even become protuberant. It has been asserted that the effect on the intercostal spaces is characteristic of enlargement from the pressure of liquid or gas, in distinction from that due to the augmented volume of the lung.[1] The intercostal depressions, however, may be effaced in cases of emphysema. The error of supposing otherwise has perhaps arisen from observations having been confined to the lower part of the chest, where the depressions are most conspicuous in health. Liquid effusion obliterates the depressions in this situation, the distension being, as has been seen, greatest at the lower part of the chest; but emphysema affecting most the superior portion of the lung, the depressions at the lower part may continue, and, if the respiration be labored, may even be greater with the inspiratory act than in health, notwithstanding the general enlargement of the chest. But it is undoubtedly true, that, at the superior portion of the chest, the intercostal depressions in persons in whom they are normally visible in these situations, may be diminished or lost in consequence of the pressure of emphysematous lung.

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[1] Racle. Op. cit.

[2] Traité de Diagnostic Médical, par le Dr. Racle. 1854.

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[1] Dr. Stokes.

Partial enlargement is incident to most of the anatomical conditions already mentioned, viz., to emphysema, pleuritic effusion, pneumo-hydrothorax, and pneumonitis, and to other affections not adequate to give rise to dilatation of the whole of one or both sides of the chest. The enlargement from emphysema is oftener partial than general. It occasions undue prominence over a portion of the chest corresponding to the seat of the affection, and proportionate in amount to the extent of the affection, with diminution or obliteration of the intercostal depressions. Affecting the superior portion of the lung on one, or more commonly on both sides, but greater on one side than on the other, a characteristic appearance is an abnormal bulging above and below the clavicle. These appearances, more marked on one side than on the other, disconnected from other signs, might lead the observer to attribute the relative depression of the supra and infra-clavicular regions on one side to disease of the subjacent lung. The evidence derived from percussion and auscultation suffice to correct this error. The physical evidences of the morbid conditions inducing abnormal depression will be wanting, while the concomitant sign of emphysema, viz., vesiculo-tympanitic resonance and feeble respiration, are found on the side on which the greater prominence exists. Over the mammary region the emphysematous lung causes greater relative fulness, especially near the sternum, with diminished obliquity of the ribs, the intercostal spaces being concealed by the pectoral muscle and the mammary gland; and if the affection exist on both sides, the chest presents an unnatural rounded or globular appearance, which is highly characteristic.

In pleuritis with effusion the lower portion of the thorax yields to the distension from the fluid gravitating to the bottom of the pleural sac, before the superior part of the chest becomes obviously enlarged from the accumulation of the liquid. Unless the quantity of effusion is large, the dilatation is partial, and situated inferiorly, in this respect contrasting with enlargement from emphysema in the majority of cases of the latter affection. The contrast as respects the signs derived from percussion and auscultation, however, generally serve to distinguish these affections from each other as broadly as possible.

In pneumo-hydrothorax the quantity of liquid at the bottom of the chest may be sufficient to occasion manifest enlargement when no obvious disparity exists above.

Pneumonitis affecting a single lobe sometimes gives rise to an appreciably increased fulness of the part of the chest situated over the solidified lung, but the enlargement is apparent in only a small proportion of instances.

Various conditions additional to these may produce partial enlargement, the more important of which are as follows:

(1.) Circumscribed pleurisy, a collection of liquid sufficient to occasion bulging, being confined within a limited area by adhesions of the surrounding pleural surfaces. Cases of this description are sometimes observed, but they are rare. I have met with an instance of a large collection of purulent fluid confined to a space five or six inches in width extending around the entire semicircumference of the lower part of the chest, firm adhesions preventing an ascent of the liquid above this space.[1] (2.) Enlargement of the spleen. Marked projection of the lower portion of the left side is sometimes due to this anatomical condition, which occurs especially in protracted or frequently renewed attacks of intermittent fever. (3.) Distension of the stomach with gas, if considerable, occasions temporarily an abnormal protrusion of the lower left ribs. (4.) Enlargement of the liver, from tumors, abscess, or hypertrophy. In this case, of course, the partial enlargement of the chest will be situated on the right side. (5.) Liquid effusion within the pericardium, and enlargement of the heart. The præcordial portion of the chest may be rendered abnormally prominent by these affections. It is a curious fact that a projection in this situation in health was found by M. Woillez to exist in a larger ratio of instances than by Bouillaud in cases of hypertrophy of the heart. It is probable that the deviation from symmetry in this situation which is found in the proportion of about one-fourth of healthy persons, has been often incorrectly attributed to the hypertrophy of the heart in the instances in which it has been observed in connection with that affection. (6.) Aneurismal and other intra-thoracic tumors. (7.) According to Dr. Chambers, deposit of tubercle may occasion bulging at the summit of the chest above and below the clavicle. This, however, has not been noticed by others, and the correctness of the observation needs confirmation.

Variations in size and form, the reverse of those just considered, may also, as has been stated, be general or partial. When contraction is general, *i. e.* affecting one or both sides, the relations of the component parts of the chest are analogous to those incident to a forced expiration.

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[1] Essay on Chronic Pleurisy, by Author.

The upper ribs are more widely separated, while the lower are approximated to each other, and the space below the xiphoid and between the lower costal cartilages is diminished.

General contraction of one side is presented in a striking degree after recovery from chronic pleurisy. The chest is diminished in all its diameters, and so appears in whatever direction it be examined. The lung, after remaining collapsed and compressed for weeks and months, does not readily assume, after the liquid is absorbed, its former volume. Moreover, the false membranes formed upon its surface, and the union of the pleural surfaces, offer a mechanical obstacle to its complete expansion. The atmospheric pressure, therefore, forces the thoracic walls to accommodate themselves to the diminished bulk of the pulmonary organ; the reduced dimensions compared with the other side (the latter becoming increased in size) are sufficiently obvious on inspection, but the altered relations of different parts, component and accessory, pertaining to the chest, are also conspicuous. The shoulder is depressed. The inferior angle of the scapula falls below the level of that on the unaffected side, and projects from the chest. The width of the lower interscapular space is notably diminished. The ribs are approximated. The nipple on the affected side is lowered. More or less spinal curvature takes place, the lateral inclination being toward the affected side. All these appearances give a characteristic aspect, by which the fact that pleurisy, with copious effusion and enlargement of the chest, has existed, is evident at a glance.

Abnormal diminution of the volume of the lung from any cause, provided the pleural cavity does not contain liquid effusion or air, is of necessity accompanied by a contraction of the chest exactly proportioned to the extent to which the pulmonary organ is reduced in bulk. Collapse, from obstruction of one of the main bronchi, involves an amount of general contraction corresponding to the diminished volume of the lung. Condensation from inflammatory exudation within the air-vesicles, remaining after the removal of this exudation, leads to some reduction of bulk, and hence contraction is sometimes observed to follow the resolution of simple pneumonitis, and is general if the inflammation and solidification affected the entire lung. The contraction under these circumstances is rarely marked, unless abundant liquid effusion has coexisted. Slight general contraction has also been observed to accompany atrophy of the pulmonary parenchyma in connection with dilated bronchial tubes. Extensive tuberculous disease induces a shrinking of the lungs, and a corresponding diminution of the size of the chest; and this effect follows long confinement to the bed with any disease.[1]

The morbid conditions which, oftener than any other, give rise to partial contraction of the chest, are incident to tuberculous disease. Abnormal depression above and below the clavicle, and more or less flattening at the summit, are occasionally observed in phthisis, and in some instances are among the striking physical evidences of that disease. These appearances may be presented early in the disease, showing that the apex of the lung becomes in some instances reduced in volume in consequence of the presence of crude tuberculous matter; but they are found more frequently, and in a more marked degree after softening and excavation have taken place. In connection with the changes by which cavities are formed, their rationale is sufficiently plain, since there occurs an actual loss of pulmonary substance to a greater or less extent. It is needless to add, that to constitute a physical sign of disease the contraction must be manifested on one side of the chest by a comparison with the other side.

Other conditions inducing partial contraction, less frequent, and clinically less important, are the absorption of liquid effusion retained by pleuritic adhesions within a circumscribed space; removal of the exudation-matter deposited in pneumonitis when the latter is confined to a single lobe, and limited collapse or atrophy.

2. MORBID APPEARANCES PERTAINING TO THE RESPIRATORY MOVEMENTS.—The respiratory movements in health have been considered in the introduction to this work, inclusive of certain modifications incident to sex, age, etc., and also variations, irrespective of disease, presented in different individuals, all of which are important by way of preparing the observer to estimate correctly morbid appearances. Incidentally, in connection with the physiological facts relating to this subject, allusion has already been made to the more prominent of those aberrations of the respiratory movements which constitute physical signs of disease.

Abnormal frequency of the respiration may be ascertained by inspection. By observing the visible motions of the chest or abdomen, the inspirations are enumerated, and the number in a given time determined. For this end, it is not necessary that the chest be exposed. Diminished frequency of the respiration implies a morbid condition seated in the nervous system, the respiratory function being affected secondarily, or symptomatically. Increased frequency is incident to various affections compromising the function of hæmatosis, such as pleurisy, pneumonitis, phthisis, and in a notable degree to capillary bronchitis. The number may be increased from the healthy average, ranging between 14 and 20 per minute, to 40, 50, and even 60. Abnormal frequency of the respirations does not necessarily denote disease of the pulmonary organs. It is incident to disorders affecting the circulation, and to hysteria. In tracing it to its source, a point of some utility is the ratio which should exist between the respirations and the pulse. As a general rule, four strokes of the heart take place in health during the time occupied by each respiration. This ratio is usually preserved in diseases not involving the heart or lungs. A pulmonary affection may be presumed to exist whenever an increase in the number of respirations is unattended by a corresponding increase in the frequency of the pulse. This may be stated as a maxim which will generally hold good; but, of course, the existence of pulmonary disease is to be determined in all cases by evidence more direct and positive.

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[1] Vide Sibson's Medical Anatomy, Fasciculus 1.

The rhythm of the respiratory movements is affected differently in connection with different morbid conditions. The inspiratory movement is somewhat shortened, as a general rule, whenever dyspnœa exists, the want of fresh supplies of atmospheric air instinctively causing the act to be hurried. Shortened inspiration is especially marked in emphysema for another reason, viz., the chest is already dilated, and the extent of its capability of expansion proportionally lessened; hence it is more quickly performed. This occurs in cases in which pain is produced by a full or deep inspiration, as in pleurisy or pleurodynia. The patient instinctively represses the inspiratory movements, and thus, as far as possible, consistently with the introduction of sufficient air for hæmatosis, shortens the duration of inspiration. An abrupt arrest of inspiration, with manifestations of acute pain, is a sign highly distinctive of the affections just named. The inspiration is also shortened by an obstruction in the larynx, which arrests the current of air before the act is completed. This occurs in œdema glottidis, in croup, and in spasm of the glottis. On the other hand, the expiration is prolonged in emphysema, owing to the impaired contractility of the lung; in bronchitis attended with obstruction of the smaller bronchial tubes; and in spasm of the muscular fibres entering into the bronchiæ, constituting nervous asthma. The prolongation is great when the three morbid conditions just mentioned are combined which is not unfrequently the case. Under these circumstances, the difficulty in the performance of expiration is especially manifest at the close of the act. The air is expelled from the lungs with a slowness which increases until the act is completed. Obstruction seated in the larynx, throat, nasal passages, or bronchi, is also attended by prolonged expiration. In all these instances the slowness with which the air is expelled is uniform through the expiratory act; in this respect differing from the instances in which the obstruction arises from want of contractility, or from obstruction seated in the smaller bronchial tubes. Dr. Sibson's observations show this to be a point of distinction.[1]

To determine with considerable accuracy the relative duration of the inspiration and expiration, the following plan is usually adopted: beating time rapidly and regularly with the finger, and counting the number of beats during each act.

An obstruction within the larynx, trachea, throat, or nasal passages, preventing the free ingress of air into the pulmonary organs, occasions certain peculiar modifications of the thoracic movements with the act of inspiration. The vacuum produced by the action of the inspiratory muscles not being filled by an adequate admission of air, the pressure of the external atmosphere causes depression at certain points where the resistance is least. These points are above and below the clavicles, the lower part of the sternum, and antero-laterally over the lowermost of the ribs attached to the sternum. This effect, reversing the healthy movements of the chest with inspiration, will be marked and extensive in proportion to the degree of obstruction. If the obstacle to the entrance of air be slight, the lower portion of the sternum only falls backward. The collapsing movement extends over the sides in proportion to the difficulty attending the ingress of air; and, in extreme cases, the entire thoracic walls are contracted, excepting the ribs to which the diaphragm is attached. Owing to the action of the diaphragm, the latter are still moved outwardly.[2] An exception to the effect on the chest just stated, occurs when, from old age, the costal cartilages have become rigid and unyielding. Under these circumstances, the thoracic walls, resisting the pressure of the atmosphere, expand, and the abdomen retracts with inspiration. The effect of obstruction on the thoracic movements is especially marked in children, owing to the greater flexibility of the thoracic walls in early life. Continued obstruction in this way leads to permanent contraction and deformity of the chest.

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[1] On the Movements of Respiration in Disease.

[2] Ibid.

In treating of the respiratory movements in health, it has been seen that they may be divided into different types, viz., *abdominal*, and *costal;* the latter being farther divisible into the *superior* and the *inferior costal type.* The combination of these several types, and their relative predominance, respectively, in other words, different modes of breathing, constitute, as already stated, important physical evidence of disease. In breathing voluntarily forced, or in laborious respiration from any morbid cause, all three types, viz., abdominal, inferior costal, and superior costal, are exemplified, but especially the two latter become prominent, compared with the habitual tranquil breathing in the male, which involves chiefly, and sometimes almost exclusively, the abdominal type. In cases of peritonitis, in which the play of the diaphragm occasions acute pain, the respiratory movements are in a great measure restricted to the thoracic walls: the breathing is costal. The same effect is produced by mechanical obstruction to the descent of the diaphragm from ascites, pregnancy, tympanitis, or abdominal tumors. On the other hand, in cases of pleuritis, or pleurodynia, in which the thoracic movements occasion acute pain, these movements being instinctively restrained, the abdominal are proportionately increased, and the breathing is said to be abdominal or diaphragmatic. In a case of double pleurisy, which came under my observation, in which the chest on both sides was half filled with liquid effusion, the lungs firmly adherent above the level of the fluid, the type of breathing was almost exclusively superior costal. The respiratory movements at the summit of the chest were remarkable. It is a repetition to state that the superior costal type of breathing, in health, is exemplified much more in the female than in the male. In paralysis affecting the costal muscles, the abdominal type of respiration becomes strongly marked.

Disparity between the two sides of the chest, as respects the respiratory movements, constitutes, in some instances, important diagnostic evidence of disease. In the dilatation of the chest on one side from large liquid effusion, the movements on that side are notably diminished, and may be almost null, whilst, on the opposite side, they are supplementarily increased. A similar disparity, but never to the same extent, exists in some cases of emphysema, in which the affection is either confined to, or is more marked, on one side. The same contrast exists in pneumo-hydrothorax. In simple pneumonia, af ing either the upper or lower lobes, the respiratory movements, i certain proportion of cases, are obviously restrained; and this is s observed after acute pain has ceased, or in cases in which that sy tom is not present. This was denied by Laennec; but a careful co parison of the two sides, in a series of cases, must convince any of the correctness of the statement.[1] A local disparity at the su of the chest is sometimes a highly significant sign of tuberculous ease. The superior costal movements, owing to pleuritic adhesi or other causes, in some instances, are notably less on the side which a tuberculous deposit exists, than on the opposite side. I will be more manifest if the respiration be labored, so as to call i action the superior costal type of breathing. It may be obvious the respiration be forced, when it is not apparent with tranq breathing. It will be more marked in females than in males, ow to the superior costal type being more prominent in them than males, irrespective of disease. An inspection of the chest, w reference to a careful comparison of the relative mobility of t two sides at the summit, is a point not to be omitted in an e ploration for evidence for or against the existence of tubercul disease. The diagnostic value of this sign of course depends on t assumption of equality in the movements of the summit of the ch in health. As the rule, provided the two sides be symmetrical conformation, this may be assumed; but in making examinations persons presumed to be free from disease, I have, in a few instanc observed a slight disparity in that situation, as well as at the low part of the chest. In view of these occasional exceptions to t general rule, a disparity in mobility, as an isolated sign, should distrusted; but, associated with other signs, it is entitled to consid able weight. Finally, a marked disparity in the movements of t two sides obtains in cases of hemiplegia.

SUMMARY.

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General enlargement involves either augmented volume of the lung on one or both sides; or the presence of liquid or air in the pleural cavity. To the former of these anatomical conditions is due the enlargement, in cases of emphysema, which may affect both sides of the chest. Enlargement of the chest from emphysema is most marked at the superior and middle portions of the chest; and the surface rarely presents a uniform regular dilatation. General enlargement on both sides is observed in some cases of bronchitis. A more frequent anatomical condition, giving rise to general enlargement, is the accumulation of liquid in the pleural sac in cases of chronic pleurisy. General enlargement from this cause is necessarily confined to one side. The dilatation, from the pressure of liquid, is more uniform, and the surface of the chest presents a more regular appearance. The intercostal depressions are effaced, in chronic pleurisy, where they are normally most conspicuous, viz., the anterior and lateral portions at the lower part of the chest. In this situation they are rarely effaced by the pressure of an emphysematous lung so as not to be marked with inspiration; but they may be diminished or lost over the superior portions in cases in which they are normally apparent in that situation. General enlargement of the chest may also proceed from pneumo-hydrothorax, and, in a slight degree, from simple pneumonitis affecting an entire lung. Partial enlargement, oftener than general, is incident to emphysema, pleurisy, pneumo-hydrothorax, and pneumonitis. It is also incident to circumscribed collections of liquid; enlargement of the spleen; distension of the stomach; augmented size of the liver; pericarditis with effusion and hypertrophy of the heart; aneurismal and other intra-thoracic tumors.

General contraction of the chest is especially marked after recovery from chronic pleurisy. It results from collapse of lung following obstruction of the bronchus leading to it; and accompanies in a slight degree the diminished volume succeeding pneumonitis affecting an entire lung, and also coexists with dilated bronchial tubes. Partial contraction above and below the clavicle is sometimes marked in cases of phthisis, being incident to the early stage, in some instances, but more frequent and more marked in an advanced period of the disease. It follows the removal of pleural effusion, attends limited collapse, and the reduction in the volume of the lung succeeding pneumonitis.

Increased frequency of the respirations is incident to affections compromising the function of hæmatosis, and is therefore observed in pleurisy, pneumonitis, phthisis, and especially in capillary bronchitis. Occurring oftener than in the ratio of one to four beats of the heart, pulmonary disease of some kind is generally indicated. The inspiration is shortened, as a general rule, in dyspnœa. It may be arrested before the act is completed by an obstruction of the windpipe, and is voluntarily arrested in consequence of pain in pleuritis and pleurodynia. It is short in emphysema, owing to the permanent expansion of the chest. The expiration is prolonged in emphysema, owing to the diminished elasticity of the lung; and in cases of obstruction in the air-passages. If, owing to obstruction in any part of the air-passages, the air-cells are not filled proportionably to the enlargement of the chest, the act of inspiration causes depression of the thoracic walls at certain points, viz., above and below the clavicles, and laterally and anteriorly at the lower part of the chest. This is more marked in children than adults, and is one of the causes of deformity of the chest. The respiration is abnormally thoracic or costal, when the play of the diaphragm is voluntarily restrained in consequence of the pain which it occasions in peritonitis, and when its descent is prevented mechanically in tympanitis and ascites, by tumors, and in pregnancy. Abdominal or diaphragmatic respiration is marked when the thoracic movements occasion suffering in pleuritis or pleurodynia, and in paralysis of the costal muscles. In health, the type of respiration in the male is chiefly abdominal, but whenever the breathing is labored, the inferior and costal types are also manifested. When the chest on one side is greatly dilated in chronic pleurisy, the side affected is nearly immovable, the movements on the unaffected side being supplementarily increased. The same disparity, but in a less degree, is exhibited in cases of emphysema in which the affection is limited to or more marked on one side. It is also observed in pneumo-hydrothorax. A disparity in the respiratory movements of the summit of the chest is sometimes a valuable sign of tuberculous disease. In cases of hemiplegia, the movements of the chest on the paralyzed side of the body are diminished, and those on the opposite side increased.

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Inspection was doubtless resorted to, in the investigation of diseases, from the earliest date in the history of medicine; but the impulse given to the subject of the physical exploration of the chest by the discovery and researches of Laennec, has led practitioners to employ, to a much greater extent than previously, and with vastly more advantage, this method of examination. The value of results obtained by inspection is very greatly enhanced by their association with the phenomena furnished by other methods, more especially by percussion and auscultation.

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CHAPTER V.

MENSURATION.

In the physical exploration of the chest, it is sometimes useful to ascertain the extent of abnormal alterations, as respects size and of respiratory movements, with greater accuracy than can be determined by the eye. For this end, measurements are resorted to. These constitute a distinct method of examination, called *mensuration*. For ordinary clinical purposes, in other words, with reference to diagnosis, the practical value of this method is very limited. It is rarely important, because the information obtained by inspection is sufficiently exact, and in some instances, even more satisfactory. The two objects for which mensuration is employed, viz., to determine abnormal alterations in size, and in the extent of respiratory movements, are quite distinct, and require separate notice.

1. Mensuration with reference to abnormal alterations in size.—Measurements with reference to alterations in size may be made in different modes. The diametrical distance between opposite points may be determined by means of compasses, constructed for that purpose, called *callipers*. For example, the antero-posterior diameter of each side, in different situations, is ascertained by placing the extremities of the two blades of the instrument in front and behind, successively, on corresponding points on the two sides, and noting the extent of the separation of the blades as indicated on a graduated scale connected with the instrument. A comparison of the relative size of the two sides at any situation, with due care, may in this way be instituted. If, however, certain precautions are not carefully observed, such as placing the extremities of the instrument on exactly corresponding points in the examination of the two sides, and being cautious not to make greater pressure on one side than on the other, the results will be likely to be fallacious; and in view of this liability, it may be doubted whether partial enlargements or contractions on one side are not generally more satisfactorily appreciated by comparison with the eye. I have had no practical experience in

the use of callipers, and so far as my knowledge extends, they are rarely made use of even by those who devote special attention to physical exploration. A difference between the two sides in any of the diameters, sufficient to become an important physical sign, is apparent on careful examination and comparison by inspection. It is chiefly in noting facts for analytical investigation, that an exactness of measurement in this or other modes, which can be expressed numerically, is desirable. For examinations with a view simply to diagnosis, it is not requisite; and this being the case, the objections to the use of an instrument, cumbrous and somewhat formidable in appearance, have justly precluded its introduction into private practice. The variations in size obtained by this mode of measurement are those already noticed under the head of Inspection, viz., on the one hand, enlargement, general and partial, due to emphysema, pleuritic effusion, etc.; and, on the other hand, contraction, incident to recovery from pleurisy, tuberculosis, etc.

Another application of mensuration consists in measuring distances on the surface of the chest, between certain prominent anatomical points. For example, the nipples, in a chest perfectly symmetrical, of an adult male, are situated on the fourth rib, or interspace, equidistant from the centre of the sternum. Enlargement of one side in connection with morbid conditions which have been already mentioned, removes the nipple on the affected side to a greater distance from the mesial line, at the same time raising it above the level of the other. Contraction of the chest, on the other hand, diminishes the distance, and depresses it below its natural situation. The extent of these changes may be accurately measured. The distance from the posterior margin of the scapula to the spinal column is increased when the chest is dilated, and diminished when the chest is contracted. In the first instance, the inferior angle of the scapula is observed to be elevated above the level of that on the unaffected side; and, in the second instance, to be lowered. These deviations from symmetry incident to disease, may be accurately ascertained by comparative measurements. The extent to which the ribs are separated or approximated by different morbid conditions may also be measured. In recording cases, it is well to express the amount of disparity between the two sides, as respects the points just mentioned, in figures; but so far as concerns the bearing of the facts on diagnosis, such precision is superfluous. The facts, as estimated by the eye, are sufficiently exact.

Another mode of practising mensuration, consists in measuring the horizontal circumference of the chest, and comparing the two sides in this respect. This may be done without difficulty, by means of a common tape or cord, with the aid of an assistant, if the patient be able to be raised to a sitting posture. The cord or tape is passed around the chest just below the scapula, one end being accurately fixed to the mesial line over the sternum in front. After being evenly adjusted with equal pressure on both sides, taking pains to see that the direction is as circular as possible, an assistant marks the point at which it crosses the spinous process of the vertebræ with ink, or by inserting a pin. The point meeting the extremity fixed at the centre of the sternum is also marked. The data for determining the circumference of the whole chest, and that of each side are in this way obtained; and since, practically, the chief object is usually to compare the two sides, it suffices to double the cord or tape from the point at which it crossed the spine, and ascertain how much one portion exceeds the other in length. In place of a common cord or tape (which answers every purpose if other means are not at hand) a graduated measure, such as tailors use, may be employed. The semi-circumference at each side is sometimes measured separately; but a difficulty in the way of accuracy arises from the liability of the chest not being equally expanded while the measurements of the two sides are taken in succession. This difficulty may in a great measure be obviated by requesting the patient to take a deep inspiration as each side is measured, and to hold the breath until the measurement is made. A better plan, however, is to use two graduated tapes joined together, the scale of inches and fraction of inches commencing on each tape at the line of junction.

One great advantage of this simple plan (attributed by Dr. Walshe to Dr. Hare) is, that it may be applied while the patient is recumbent. The point of junction being fixed over the spine, and the two tapes brought forward, the circumference of each side is shown by a glance at the centre of the sternum. Of the convenience of this plan I can speak from my own experience. Comparison of the semicircular measurements of the two sides enables the examiner to form an idea of the extent to which the dimensions of one side are either increased or diminished by disease; but the actual difference of size, it is to be borne in mind, does not represent exactly the amount of a morbid increase or diminution, since, as a general rule, the two sides are normally unequal. In the majority of persons the right semi-circumference exceeds the left, the mean disparity being about half an inch. In a small proportion of individuals the two sides are equal, and in a few instances the left semi-circumference exceeds the right. The latter is found to occur oftener among left-handed persons. Owing to these natural differences, the fact of a disparity as shown by the results of mensuration, if it be but small or moderate, does not necessarily denote disease. To become a morbid sign it is to be taken in connection with other signs, unless the disparity exceed the range of normal variations; and if this be the case, comparison of the two sides by inspection suffices to establish the existence of morbid enlargement or contraction. Mensuration under these circumstances only assists in forming a closer estimate of the extent of the deviation from the normal dimensions, a point not without interest, but not essential to diagnosis. Moreover, measurement of the horizontal circumference of the chest affords evidence only of general, not of partial enlargement or contraction of one side. Partial projection or depression may exist without a corresponding increase or diminution of the semi-circumference of the side affected, and under these circumstances the latter must be determined by inspection, or by the callipers. The advantage of circular measurement does not relate to the determination of the existence of a morbid disparity in size between the two sides, so much as to another object, viz., to ascertain the variations in the amount of morbid increase at different periods in the same case. This object has reference mainly to a single disease, viz., chronic pleurisy, including empyema. Mensuration employed daily, or at intervals more or less brief, during the continuance of this disease, the result being noted, affords exact information respecting the progress in the accumulation or removal of the liquid effusion. The practitioner, in other words, is able to determine with precision whether the quantity of effusion be increasing or lessening, or stationary. Information on these points may also be derived from inspection, but not so promptly and less accurately. The positive or negative effects of different therapeutical measures are demonstrated in this way by the evidence afforded by mensuration, and in this point of view measurements repeated more or less frequently are of not a little utility in regulating the treatment. These remarks with reference to pleurisy, are measurably applicable to pneumo-hydrothorax, and to some extent to emphysema. The progress in the slow expansion of the chest after the contraction which immediately disease. It follows the removal of pleural effusion, attends limited collapse, and the reduction in the volume of the lung succeeding pneumonitis.

Increased frequency of the respirations is incident to affections compromising the function of hæmatosis, and is therefore observed in pleurisy, pneumonitis, phthisis, and especially in capillary bronchitis. Occurring oftener than in the ratio of one to four beats of the heart, pulmonary disease of some kind is generally indicated. The inspiration is shortened, as a general rule, in dyspnœa. It may be arrested before the act is completed by an obstruction of the windpipe, and is voluntarily arrested in consequence of pain in pleuritis and pleurodynia. It is short in emphysema, owing to the permanent expansion of the chest. The expiration is prolonged in emphysema, owing to the diminished elasticity of the lung; and in cases of obstruction in the air-passages. If, owing to obstruction in any part of the air-passages, the air-cells are not filled proportionably to the enlargement of the chest, the act of inspiration causes depression of the thoracic walls at certain points, viz., above and below the clavicles, and laterally and anteriorly at the lower part of the chest. This is more marked in children than adults, and is one of the causes of deformity of the chest. The respiration is abnormally thoracic or costal, when the play of the diaphragm is voluntarily restrained in consequence of the pain which it occasions in peritonitis, and when its descent is prevented mechanically in tympanitis and ascites, by tumors, and in pregnancy. Abdominal or diaphragmatic respiration is marked when the thoracic movements occasion suffering in pleuritis or pleurodynia, and in paralysis of the costal muscles. In health, the type of respiration in the male is chiefly abdominal, but whenever the breathing is labored, the inferior and costal types are also manifested. When the chest on one side is greatly dilated in chronic pleurisy, the side affected is nearly immovable, the movements on the unaffected side being supplementarily increased. The same disparity, but in a less degree, is exhibited in cases of emphysema in which the affection is limited to or more marked on one side. It is also observed in pneumo-hydrothorax. A disparity in the respiratory movements of the summit of the chest is sometimes a valuable sign of tuberculous disease. In cases of hemiplegia, the movements of the chest on the paralyzed side of the body are diminished, and those on the opposite side increased.

HISTORY.

Inspection was doubtless resorted to, in the investigation of diseases, from the earliest date in the history of medicine; but the impulse given to the subject of the physical exploration of the chest by the discovery and researches of Laennec, has led practitioners to employ, to a much greater extent than previously, and with vastly more advantage, this method of examination. The value of results obtained by inspection is very greatly enhanced by their association with the phenomena furnished by other methods, more especially by percussion and auscultation.

CHAPTER V.

MENSURATION.

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instrument as to be only available in hospital or office practice. Mr. Coxeter, surgical instrument maker, in London, has invented a substitute, which is very convenient and portable. It consists of a bag, made of India-rubber cloth, of sufficient size to hold the utmost amount of air that a person with the largest vital capacity can expel from the lungs, with two apertures, to one of which is fitted a glass mouth-piece, while the other communicates with a cylindrical bag, holding, when fully distended, fifty cubic inches of air. The latter is the meter, and by a scale marked on its exterior, any quantity less all the amount it will contain may be measured. The orifices of the large bag or reservoir are regulated by stop-cocks; and by an orifice at the extremity of the meter, also regulated by a stop-cock, its contents may be expelled. The patient breathing into the reservoir with as prolonged an expiration as possible, the air is retained by closing the stop-cocks. It is then measured, by refilling the meter until all the contents of the reservoir are expelled. The whole apparatus can be folded compactly, and placed in a leathern case, not too bulky to carry in the pocket.

SUMMARY.

The objects of mensuration are to determine, first, alterations in the size of the chest, which may be partial or general; and, second, alterations in the extent of respiratory movements. Partial enlargement or depression is measured by means of callipers; general enlargement or contraction, is determined by comparing the horizontal semi-circumference of the two sides, which is ascertained by the employment of a graduated inelastic tape, and by measuring distances between certain anatomical points, such as the distance of the nipple from the mesial line, and the space between the posterior margin of the scapula and the spinal column. In scientific researches involving observations recorded for analytical investigation, it is convenient and important to employ the instruments just mentioned, expressing results in figures; but, in general, alterations in size may be ascertained sufficiently for diagnosis, by inspection. Clinically, the advantage of mensuration with reference to comparison of the dimensions of the two sides, relates to variations taking place at different periods in the same case, these variations sometimes being important to be considered in connection with therapeutical agencies; and, thus restricted pleuritis with effusion is the affection in which this method of exploration is particularly useful. According to the researches of M. Woillez, mensuration practised daily during the career of acute diseases, shows first a progressive enlargement of the whole thorax during the development of the disease; second, a stationary condition of enlargement while the acute symptoms continue; and, third, a gradual return to the normal size while resolution of the disease is going on. This series of alterations is accounted for by M. Woillez on the hypothesis of pulmonary congestion existing as an important element of all acute affections.

Abberrations of the respiratory movements are determined by the chest-measurer, and by the stethometer. The first measures the extent of motion, at any part of the chest, in the direction of its diameter; the latter measures the amount of expansive movement. These instruments, although extremely serviceable in certain scientific researches, are not needed in determining the existence or non-existence of abnormal movements, inasmuch as comparison of the two sides with the eye suffices for that purpose. To institute a comparison between the two sides as respects the relative extent of general expansibility, the difference may be taken between the horizontal circumference after a deep inspiration, and that after a forced expiration: this mode of determining the extent of general motion does not secure complete accuracy, but it is sufficiently exact for ordinary practical purposes.

The spirometer invented by Dr. Hutchinson, is designed to determine the "vital capacity" of the lungs, by ascertaining the quantity of air which can be expelled by a single prolonged expiration; the results of this method of mensuration are, however, in a great measure, dependent on circumstances affecting muscular power, irrespective of the condition of the pulmonary organs; and the degree of the vital capacity of different individuals is found to differ widely in health.

It is rarely, therefore, that positive information respecting the existence of pulmonary disease is to be obtained from this source, in cases in which symptoms and other signs fail to indicate the fact. In a negative point of view, however, the spirometer may sometimes be useful. If the degree of vital capacity be found to equal or exceed the average, it warrants the presumption that disease does not exist; or, if the amount of vital capacity proper to an individual in health be known, and it be found that this amount is not diminished, it may be fairly presumed that the pulmonary organs are sound.

HISTORY.

The remarks made under this head, in connection with the sign of Inspection, Chapter IV., are equally applicable to mensuration.

CHAPTER VI.

PALPATION.

EXAMINATION by palpation consists in simply applying the palmar surface of the hand or the fingers to the exterior of the chest. This is one of the least important of the methods of physical exploration, but in some instances it furnishes signs of considerable importance. In general, the evidence of disease which it affords is auxiliary to or confirmatory of information, more positive and complete, derived from other methods. The phenomena appreciable by the application of the hand to the chest are of different kinds. I shall proceed at once to notice those which are important to be borne in mind with reference to the diagnosis of intra-thoracic diseases.

By means of the touch, the existence of tenderness on pressure, its degree, situation, and extent, are ascertained. Manual examination assists in determining whether it be seated in the integument, or within the thorax. If it be owing to sensitiveness of the surface, it will be superficial; mere contact of the fingers will excite pain, which is not proportionately increased if firm pressure be made. If intra-thoracic, the hand lightly applied will be supported, and the suffering will be according to the force employed. In short, the rules by which a neuropathic tenderness is distinguished from that due to inflammation, are available here, as in other situations.

The elasticity of the thoracic walls is ascertained by manual examination. Information on this point, it is true, may be obtained, incidentally, in practising percussion; but in order that the attention shall not be divided between two objects, it is useful to make pressure with express reference to the sense of resistance. The elasticity of the walls of the chest is diminished in proportion as the pulmonary substance is rendered non-elastic by solidification; and, also, in a notable degree, when a considerable quantity of liquid is contained within the pleural sac. In connection with other signs, this possesses considerable importance.

patient extremely emaciated. The concussion produced by liquid within a superficial cavity thrown with force against the thoracic walls by the act of coughing, is sometimes very plainly perceptible to the touch, as well as to the eye.

The divergence and convergence of the ribs, whether persisting or incident to the respiratory movements, are appreciated by palpation better than by inspection. Placing a finger in the intercostal spaces, the two sides can be accurately compared with respect to their relative width, and the relation of the ribs in respiration. In this way it may be ascertained, that when one side of the chest is enlarged, either by increased volume of lung or by pleural effusion, the lower intercostal spaces are widened, and those between the upper ribs narrowed. The ribs, under these circumstances, on the affected side, will be found to remain comparatively motionless during the movements of respiration on the affected side, while, on the opposite side, those situated at the lower portion of the chest manifestly become more widely separated by the inspiratory act. Obliteration of the hollows between the ribs, from the pressure of a liquid, is more distinctly felt than seen. The smooth, even surface which characterizes the affected side in cases of chronic pleurisy, or empyema, with notable dilatation of the chest, is appreciated by the touch better than by the eye. In the same manner, tactile examination serves to distinguish the comparatively unequal enlargement due to emphysema.

With the hand applied on the chest, the extent of motion at that part with inspiration is apparent. A comparison of the two sides at different points may in this way be made with respect to the relative amount of expansibility, the evidence obtained by ocular examination being thus confirmed or modified. In examining the female chest, if sensitiveness on the score of delicacy precludes a satisfactory examination by inspection, palpation may be employed as an alternative.

The respirations may be conveniently enumerated by means of palpation. In one respect this method has an advantage over inspection, viz., the movements being felt, the eyes are left unoccupied except to note the time during which the respirations are counted. In the female, the hand may be applied, for this object, in the infra-clavicular region; in the male, the upper part of the abdomen is to be preferred.

The situation of the apex impulse of the heart is sometimes an important point in the diagnosis of affections pertaining to the pulmonary organs. In large pleuritic effusions, and in some cases of emphysema, the heart is removed from its normal situation. Under these circumstances the impulse may be felt, as well as seen, at a point more or less distant from that where it is to be sought for in health. A collection of liquid in the right pleural sac pushes the heart in a line somewhat diagonal, upward and outward, to the left of its normal situation. If the liquid be contained in the left pleural cavity, and sufficiently copious, the organ is carried upward and laterally to the right, and may be found to pulsate between the fifth and seventh ribs to the right of the sternum. The absorption of large liquid effusions in either side also tends to displace the heart, through the influence of atmospherical pressure or suction. This effect, but to a less extent, has been observed in other affections attended with diminution of the bulk of the lung, viz., after absorption of inflammatory exudation, collapse or atrophy, and in cases of tuberculosis involving considerable destruction of the pulmonary substance. Absence of the heart's impulse, owing to its being pushed backward from the thoracic walls by the increased volume of the overlapping lung, is one of the signs of emphysema; and in some instances of this affection, the organ is depressed, so that its impulse is transferred to the epigastrium.

Finally, vibratory motions of the walls of the chest accompanying the act of speaking, and, under certain circumstances, respiration, constitute physical signs, possessing, in some cases, considerable importance. If the palmar surface of the hand be lightly applied over the healthy chest in certain situations, the vibrations of the vocal chords, propagated along the bronchial tubes, and communicated to the thoracic parietes, give rise to a thrilling sensation, called the *vocal fremitus.* This is strongly marked if the fingers are placed upon the larynx or trachea. It is more or less apparent in the infra-clavicular region; in an inferior degree in the mammary and infra-mammary region; ceasing below the line of hepatic dulness; slight, if appreciable behind, over the scapulæ; generally felt, and sometimes well marked in the inter- and infra-scapular and axillary regions. The normal vocal fremitus, like the vocal resonance, the respiratory murmur, and the sound on percussion, is found to present great variations in degree in different individuals entirely free from pulmonary disease. In some persons it is strongly marked; in others moderate, in others slight; and sometimes it is nowhere appreciable. Other things equal, it is stronger in proportion as the chest is thinly covered with fat and muscle. The character of the voice, also, materially affects its intensity. In general, the fremitus is notably stronger in persons whose voices are powerful and low in pitch. It is therefore oftener, present, and is apt to be intense in adult males, than in females and children, whose voices are feebler and more acute. It is appreciated by the ear applied to the chest, even better than with the hand, and in connection with the subject of vocal resonance, it has already been incidentally noticed. As already remarked in that connection, the vocal fremitus does not sustain any fixed relation to vocal resonance. The latter may be intense while the former is slight, and *vice versa*. This statement applies equally to health and disease. A loud shrill voice is most favorable for intensity of vocal resonance, whether normal or morbid; on the contrary, as just stated, bass tones are most likely to give rise to a strong fremitus. The intensity of the fremitus, in health or disease, is affected by position. In the great majority of instances it is more strongly marked if the patient be recumbent, than in the sitting posture.

With respect to the normal vocal fremitus, it is important to bear in mind that uniformity of the two sides of the chest is the exception rather than the rule. In the larger proportion of individuals it is more marked on the right than on the left side. This is true, not only of the summit of the chest, but at the lateral-posterior portion inferiorly. This natural disparity must be taken into account in estimating the effects produced by disease.

The vocal fremitus may be increased, diminished, or suppressed, by morbid conditions. In a positive and negative point of view, therefore, the voice, by means of palpation, furnishes physical evidence of disease. An increase of the vocal fremitus occurs in solidification of lung, especially from inflammatory exudation and tuberculous deposit; less frequently and in a less degree, in connection with œdema, extravasation of blood, or carcinoma. Dilatation of the bronchial tubes contributes to its intensity. Bearing in mind the disparity between the two sides just stated, a relatively greater amount of fremitus on the right than on the left side, affords equivocal evidence of the existence of disease. If, however, a greater amount be found on the left side, it is highly significant of a morbid condition. Seated at the summit of the chest, in conjunction with symptoms denoting a chronic pulmonary affection, it points to a tuberculous deposit. Existing in the left infra-scapular and infra-axillary regions, it is one of the signs indicative of consolidation from pneumonia. It becomes a valuable sign of the second stage of pneumonia in some instances in which exaggerated vocal resonance, and even the bronchial respiration, are deficient.

The normal vocal fremitus is diminished or suppressed, as the rule, whenever the lung is removed from the thoracic walls by the accumulation of liquid or gas within the pleural cavity. Some exceptions to this rule, as with respect to the absence of vocal resonance and respiratory sound, under similar circumstances, have been observed. Generally, in cases of pleurisy with effusion, of hydrothorax, and of pneumo-hydrothorax, fremitus on the affected side is absent, or if present, relatively feeble. This negative sign is of more value if it be found on the right side, the rule in this instance being the reverse of that applicable to increased fremitus. The reason for the rule is obvious. Were we to attempt to arrive at a diagnosis by exclusive reliance on the vocal fremitus, it would be necessary to enjoin caution not to regard the normal fremitus remaining on the left side, in cases in which it is diminished or suppressed by disease on the right side, as proceeding from a morbid condition of the left lung. The liability to this error will always be obviated by attention to associated signs.

In some cases of pleurisy, the vocal fremitus is increased at the summit of the chest, over the lung condensed by compression, while it is feeble or null below the level of the liquid.

In emphysema, the vocal fremitus is generally diminished, but, according to Walshe, this rule is not without exceptions, and the fremitus may even be increased.

As already remarked, the normal vocal fremitus on the right side ceases below the line of hepatic dulness. In cases of enlargement of the liver, in which it encroaches on the thoracic space, absence of fremitus constitutes one of the signs assisting in determining the fact that the flatness on percussion, extending a greater or less distance above the normal limits, is not due to consolidated lung.

Certain motions of the chest, perceptible on manual examination, are occasionally incident to the respiratory movements. The bronchial rales, both dry and moist, *i. e.* the mucous, sonorous, and sibilant, and the gurgling incident to cavities, sometimes cause a vibratory thrill, appreciable on application of the hand. This is called the *rhonchal fremitus*. In some of the instances in which a pleural friction-sound is present, the rubbing of the roughened surfaces is distinctly apparent on palpation. This never occurs save when a friction-sound is, at the same time, strongly marked on auscultation. It is observed at a late stage in pleurisy, after absorption of liquid has brought the pleural surfaces into contact, the period of the disease when the friction-sound is oftenest observed, and is most apt to be loud and rough.

SUMMARY.

Palpation furnishes information respecting the degree, situation, and extent of soreness of the chest; the degree of elasticity of the thoracic walls; the changes in form and size; inequalities of the surface; the condition of the intercostal spaces, and the amount of convergence or divergence of the ribs in respiration.

In some instances, determining the existence of fluctuation, it establishes the presence of liquid in the pleura, or in a superficial pulmonary excavation. It may be employed in estimating the extent of motion with the respiratory acts, and in a comparison of the two sides of the chest, in different situations, in this respect. It affords a convenient mode of enumerating the respirations. It is useful in determining whether the heart remains in its normal position, or has been dislocated in connection with disease affecting the pulmonary organs.

The *vocal fremitus*, felt when the hand is applied to the healthy chest, is increased, diminished, or suppressed, in connection with different forms of disease. It is frequently increased in cases of solidification, especially from inflammatory exudation, and from tubercle. An increased amount of fremitus, situated on the left side, according to the part of the chest at which it is observed, is a significant sign of either phthisis, or pneumonia. Diminished or suppressed fremitus is incident to diseases in which the lungs are removed from contact with the thoracic walls, viz., pleurisy with effusion, and pneumo-hydrothorax. It coexists with flatness on percussion over the space occupied by an enlarged liver. Diminished and suppressed fremitus are much more valuable as physical signs, when they occur on the right side, in consequence of the normal fremitus being generally more marked on that side.

A fremitus sometimes accompanies the bronchial rales, and gurgling; and a rubbing sensation is occasionally felt in conjunction with a loud and rough friction-sound, occurring in pleurisy, generally after the removal of the liquid effusion.

HISTORY.

The general remarks under this head, made with reference to Inspection, Chapter IV, are also applicable to palpation. The absence of the normal vocal fremitus, as a sign of pleuritic effusion, was first pointed out by M. Reynaud.

CHAPTER VII.

SUCCUSSION.

SUDDEN agitation of the body, under certain circumstances of disease, occasions a splashing noise, which is quite pathognomonic. To produce it, the practitioner, applying his ear to the chest, grasps the shoulder of the patient, and moves abruptly, but not violently, the trunk backward and forward. This method of examination is called *Succussion.* A splashing noise is the only physical sign developed by this method; and, as just stated, it has a special signification, representing, in the vast majority of the cases in which it occurs, a particular form of disease, viz., pleurisy with perforation, or the affection commonly called pneumo-hydrothorax.

The term splashing, is descriptive of the character of the noise. It may be imitated by shaking a bottle, partially filled with water, the remainder of the space being occupied with air. It is analogous to the gurgling occasionally produced in large pulmonary excavations by the impulse of the heart, and more especially, by acts of coughing. The conditions requisite for the production of the sign, are a cavity of large dimensions, partially filled with liquid, and partially with air or gas. These conditions obtain in pneumo-hydrothorax. In that affection, air, or gas, and liquid, are contained within the pleural cavity. It involves, in the great majority of cases, perforation of the lung, but this is not essential to the production of the sign. Air and gas within the pleural sac, without communication with the bronchial tubes, or externally through the thoracic walls, suffice for its manifestation. The sign would be entirely pathognomonic, except that it is sometimes observed in cases of a very large tuberculous excavation. It is obvious that a cavity of great size may, at times, furnish the necessary physical conditions, viz., sufficiency of space containing liquid and air. With this exception (and the exceptional instances are extremely infrequent), the sign belongs exclusively to pneumo-hydrothorax.

The intensity of the splashing noise, and the facility with which it is produced, vary considerably in different cases. It may not be apparent save when the ear is either in contact with, or in close proximity to the chest; but in some instances, it is sufficiently loud to be heard at a distance. I have known it to be so intense as to be audible throughout a large lecture-room. It is produced, not alone by succussion practised for that purpose, but by any sudden, quick motions, sufficient to occasion agitation of the liquid. Hence, it not infrequently arrests the attention of the patient. Dr. Stokes relates a case, in which a patient, affected with pneumo-hydrothorax, was able to take horseback exercise, but whenever he rode in a gallop, or hard trot, he was annoyed by the splashing within the chest. An analogous case has fallen under my observation. The patient, a female, lived for several months after the occurrence of perforation in connection with tuberculosis, followed by pneumo-hydrothorax; and retained sufficient strength to walk about, and to ride in the open air. Sudden change of position, rising up, sitting down, etc., produced a splashing noise, very apparent to herself; and in riding in a carriage, every jolt was attended with the same effect.

The sign is not uniformly present in cases of pneumo-hydrothorax. Its absence in a certain proportion of instances, probably depends on the too large proportion of liquid to the quantity of air or gas, or on the too great consistency of the liquid, or on both combined. The thinner the liquid the more readily is the splashing produced. The quality of the noise, as well as its intensity, varies. It sometimes has a high-pitched ringing character, and may be commingled with well-marked metallic tinkling.

A noise resembling somewhat thoracic splashing originates within the stomach when this organ contains a certain quantity of liquid, and is at the same time distended with gas. The associated symptoms and signs will always obviate the liability to doubt arising from this resemblance. Aside from the evidence afforded by succussion, the diagnostic criteria of pneumo-hydrothorax are unequivocal, so that the former might, without much inconvenience, be dispensed with. The diagnosis of phthisis, also, at the stage of the disease when it would be possible for succussion to be available, is sufficiently clear without resorting to this method of examination.

SUMMARY.

Frequently in cases of pneumo-hydrothorax, and occasionally in cases of phthisis with a very large excavation, succussion occasions a splashing noise, produced by the agitation of liquid in a space of considerable size, partially filled with air or gas. Owing, however, to the sufficiency of other signs, in connection with symptoms, this method of exploration is of trifling value with reference to diagnosis.

HISTORY.

Hippocrates was aware of the fact that by shaking the bodies of patients, a splashing noise was sometimes produced. This method was practised by him, and hence, the sign is sometimes called the "Hippocratic succussion-sound." The fact is also mentioned by several of the ancient writers. Hippocrates attributed the noise to the presence of pus, without recognizing the necessity of the presence of air or gas. He regarded it as a sign of empyema. Its pathognomonic significance has been established by modern investigations.

CHAPTER VIII.

RECAPITULATORY ENUMERATION OF THE PHYSICAL SIGNS FURNISHED BY THE SEVERAL METHODS OF EXPLORATION.

I. Percussion.

1. Exaggerated vesicular resonance.
2. Diminished vesicular resonance.
3. Absence of resonance.
4. Tympanitic resonance.
    - *a*. Amphoric.
    - *b*. Cracked-metal.
      (*Bruit de pot fêlé.*)

II. Auscultation.

PHENOMENA INCIDENT TO RESPIRATION.

A. *Modifications of the Intensity of the Vesicular Murmur.*

1. Increased intensity of vesicular murmur.
2. Diminished intensity of vesicular murmur.
3. Suppressed respiration.

B. *Modifications of the Quality, etc., of Respiratory Sounds.*

1. Bronchial respiration.
2. Broncho-vesicular (rude) respiration.
3. Cavernous and amphoric respiration.

C. *Modifications of the Rhythm of Respiratory Sounds.*

1. Shortened inspiration.
2. Prolonged expiration.
3. Interrupted inspiration or expiration.

D. *Adventitious Respiratory Sounds.*

1. Dry, vibratory, bronchial rales (sibilant and sonorous).

2. Moist, bubbling, bronchial, or mucous rales (coarse and fine).
3. Sub-crepitant rale.
4. Crepitant rale.
5. Gurgling.
6. Indeterminate rales.
    - *a.* Crumpling.
    - *b.* Crackling.
7. Friction or attrition-sounds.

PHENOMENA INCIDENT TO THE VOICE.

1. Exaggerated vocal resonance and bronchophony.
2. Diminished and suppressed vocal resonance.
3. Pectoriloquy and amphoric voice.
4. Ægophony.

PHENOMENA INCIDENT TO THE ACT OF COUGHING.

1. Bronchial cough.
2. Cavernous cough and amphoric cough.
3. Metallic tinkling.

PHENOMENA INCIDENT TO THE CIRCULATION.

1. Abnormal transmission of heart-sounds.
2. Arterial bellows-murmur.

III. INSPECTION.

A. Morbid Appearances pertaining to the Size and Form of the Chest.

1. Enlargement.
    - *a.* General.
    - *b.* Partial.
2. Contraction.
    - *a.* General.
    - *b.* Partial.

B. Morbid Appearances pertaining to the Respiratory Movements.

1. Abnormal frequency of the respirations.

2. Shortened inspiration.
3. Prolonged expiration.
4. Abdominal or diaphragmatic respiration.
5. Costal or thoracic respiration.
6. Exaggerated superior costal respiration.
7. Respiratory movements on one side diminished or suppressed.
8. Respiratory movements on one side exaggerated.
9. Disparity in the superior costal movements between the two sides.

IV. Mensuration.

1. Alterations in size and form enumerated under the head of Inspection.
2. Alterations in respiratory movements enumerated under the head of Inspection.

V. Palpation.

1. Tenderness on pressure.
2. Increased or diminished elasticity of thoracic walls.
3. Abnormal inequalities from depression or projection.
4. Pulsation from cardiac impulse or arterial throbbing.
5. Fluctuation.
6. Abnormal conditions pertaining to intercostal spaces.
7. Disparity between the two sides in expansibility, general or local.
8. Abnormal situation of heart's impulse.
9. Exaggerated vocal fremitus.
10. Diminished or suppressed vocal fremitus.
11. Rhonchal fremitus.
12. Pleural rubbing.

VI. Succussion.

1. Splashing.

CORRELATION OF PHYSICAL SIGNS.

Of the various morbid conditions to which the respirat
are subject, each gives rise, almost invariably, to a group of p
phenomena. As with symptoms, so with signs, a greate
number accompany individual diseases: and hence, they ar
presented to the clinical observer isolated, but in certain c
tions. In the diagnosis of intra-thoracic affections, it is se
ever the case that exclusive reliance is to be placed on a sing
more than upon a separate symptom; but the discriminatio
affection from another involves collective physical not less th
evidence. Very few, if any, of the physical indications of p
disease are pathognomonic. As a general rule, their diagno
portance is in a great measure derived from union with eac
and this aggregation of different signs, while it is often ess
diagnosis, always renders it much more exact and positive.
of signs, no one of which by itself would be reliable, sometime
to the nature and seat of a disease with greater precision t
most distinctive characteristic taken singly. To cite an illu
of this truth, the existence of tuberculous disease may be est
by a series of phenomena, each of which, without the other
possess trivial importance; but, collectively, they render t
nosis as complete as possible. On the other hand, let one
most significant of the physical signs be selected, for exampl
lic tinkling: guided by it exclusively, there would be a lia
error, for, although in the immense majority of the cases in

are physical signs individually insufficient as diagnostic criteria, but the same sign may be incident to different affections. The bronchial respiration, for instance, belongs equally to the semeiological history of pneumonitis and tuberculosis. Absence of respiratory sound occurs in cases of emphysema and in cases of pleurisy,—two very dissimilar forms of disease. The significance of particular signs, in such instances, depends in a great measure on the combinations in which they are found. Thus, absence of the respiratory murmur in emphysema is associated with an abnormal clearness of percussion-resonance; on the other hand, in pleurisy, it is accompanied by flatness on percussion. The significance of the respiratory sign in these two instances is borrowed from the coexisting signs, the latter, it will be observed, being exactly opposite in their character.

It is unnecessary to adduce farther illustrations to show the importance of studying not only physical signs separately, but their mutual relations, by which they are united in groups or combinations, in connection with different morbid conditions. These relations have already, in the foregoing pages, to some extent been incidentally noticed, and hereafter, in treating of the diagnosis of individual diseases, the manner in which the physical phenomena furnished by the several methods of exploration are grouped will necessarily be considered. But, before entering on the second part of this work, there will be an advantage in devoting some attention to the *correlation of physical signs;* in other words, taking up, *seriatim*, certain important phenomena pertaining to physical exploration, and enumerating those with which each is found to be correlatively associated in clinical observation. To this object the present chapter will be devoted. What are the different groups or combinations formed by the union of physical signs in consequence of their pathological affinities? and what are the morbid conditions which these different groups or combinations of signs represent? Although the answers to these questions involve to some extent a recapitulation of facts already presented, and also an anticipation of points which are hereafter to be considered, the student will not find it a useless expenditure of time to bestow some attention on the correlation of physical signs, in order to become more familiar with what may be termed the rules of syntax regulating the language of physical exploration, and as preliminary to the department of the subject which remains to be considered, viz., the diagnosis of particular diseases.

To consider all the physical phenomena, respectively, which are furnished by the several methods of exploration, would involve needless and tedious repetitions. It will suffice to take up the individual signs belonging to percussion, and to auscultation so far as concerns respiratory and friction sounds. An enumeration of the signs sustaining correlative relations to these, will be found to embrace the more important of the phenomena pertaining to auscultation of the voice, and to the remaining methods of exploration. Of the respiratory signs, I shall omit those consisting in abnormal modifications of rhythm, because the two first, viz., shortened inspiration and prolonged expiration, in the great proportion of instances, are merely elements either of the bronchial or the broncho-vesicular respiration; and the third modification, viz., interrupted respiration, belongs to the category with certain other phenomena, viz., the rales, which, it will be seen, cannot be said to have any correlative signs. Excluding, then, of the modifications of rhythm, I shall proceed to take up, in the order in which they were enumerated in Chapter VIII, the phenomena furnished by percussion, and by auscultation so far as it relates to respiratory and friction sounds, presenting, briefly, the groups or combinations into which they respectively enter, by virtue of their relations to similar anatomical conditions of disease.

SIGNS CORRELATIVE TO THOSE FURNISHED BY PERCUSSION.

1. EXAGGERATED VESICULAR RESONANCE.—Occurring in consequence of the activity of the lung on one side being supplementarily increased, the correlative sign pertaining to auscultation is an exaggerated vesicular murmur. Under such circumstances, however, these signs are not intrinsically morbid. They are physiological phenomena exaggerated, but not to a point to be in themselves pathological, and they denote intra-thoracic disease, not at the portion of the chest corresponding to the situation where they are observed, but, inferentially, at another part, and generally on the opposite side. A correlative sign obtained by inspection and mensuration is increased extent of the respiratory movements. The pathological relation of exaggerated resonance to emphysema is more direct and important. The morbid condition in this affection consists in an abnormal accumulation of air, generally within the pulmonary cells, in some rare instances in the interlobular and sub-serous areolar tissue. The correlative sign derived from auscultation is directly the reverse of the

in the previous instance, viz., diminution of the respiratory murmur, amounting sometimes to suppression. This combination is highly significant. Other auscultatory signs are frequently associated, but they are incident, not purely to the emphysema, but to coexisting affections, especially bronchitis. This remark applies to the bronchial rales so often present in cases of emphysema. Associated signs, determined by inspection, are thoracic enlargement, general or local, corresponding to the extent of the emphysematous dilatation; diminished respiratory movements; obliteration of intercostal depressions; diminished obliquity of the lower ribs; divergence of the lower, and convergence of the upper ribs, if the emphysema be general. The relation of exaggerated resonance to emphysema is the rule; but occasional exceptions are present in cases of great tension of the thoracic walls from the pressure of an over-distended lung. In these exceptional instances the resonance may be diminished in place of being exaggerated. The vesicular quality of resonance in cases of emphysema is rarely if ever lost, but it is more or less diminished. It is vesiculo-tympanitic. In proportion as the intensity of resonance is diminished by tension, the vesicular quality is impaired, and the tympanitic predominates.

Exaggerated percussion-resonance incident to the temporary emphysematous condition which sometimes obtains in bronchitis, pulmonary catarrh, and bronchial spasm, involves, as correlative signs, the adventitious sounds which pertain to these affections, viz., the dry and moist bronchial rales.

2. DIMINISHED VESICULAR RESONANCE.—In the exceptional instances of emphysema in which this modification of percussion-resonance occurs, the correlative signs will, of course, be the same which, in the majority of instances of that affection, are combined with exaggerated resonance.

Commonly the affections to which diminution of resonance is incident are those involving either liquid pleural effusion, viz., pleurisy and hydrothorax; or increased density of lung from deposit of liquid or solid matter, viz., pneumonitis, tuberculosis, œdema, pulmonary apoplexy, carcinoma, etc. The correlative signs in these two classes of affections are far from identical; nor are they uniform in the different affections included in the same class.

In pleuritic effusion sufficient to diminish but not abolish the vesicular resonance, correlative auscultatory signs are, diminished respiratory murmur, and in some instances ægophony. Correlative signs determined by palpation are, diminished or suppressed vocal vibration, and increased force of resistance to pressure.

In solidification from pneumonitis and tuberculosis, the correlative auscultatory phenomena, in the majority of instances, are more or less of the characters of the broncho-vesicular, or of the bronchial respiration, together with exaggerated vocal resonance, or bronchophony, and increased vocal fremitus. Exceptional instances are not very infrequent in which, instead of these signs being associated, the respiratory sound is abolished and the vocal resonance and fremitus not increased. The latter constitute the rule, rather than the exception, in the other affections involving abnormal density of lung, viz., œdema, pulmonary apoplexy, carcinoma, etc.

A correlative sign in cases of œdema, and, less constantly, in cases of pulmonary apoplexy, is the sub-crepitant rale. The crepitant rale is generally associated with diminished percussion-resonance in pneumonitis, but the converse does not hold good to the same extent; in other words, the crepitant rale often appears before the percussion-resonance is sensibly diminished.

Diminished respiratory movements may be combined in all the affections named, but oftener in pneumonitis and tuberculosis. Increased force of resistance on pressure, and diminished elasticity, is a correlative sign common to all the varieties of solidification.

3. Absence of Resonance.—The anatomical conditions giving rise to diminished resonance may be sufficient to abolish it, rendering the percussion-sound flat. Absolute flatness being in the great majority of instances due to the presence of a considerable quantity of liquid in the pleural cavity, the correlative auscultatory signs are absence of respiratory sound, and of vocal resonance, with notably diminished elasticity of the thoracic walls. This combination of signs is highly diagnostic; yet the rule is not without exceptions, diffused bronchial respiration being associated with flatness in some cases of large effusion. Absence of vocal fremitus is another correlative sign. If the amount of effused liquid be great, inspection and mensuration furnish important associated signs, viz., enlargement of the chest; obliteration of the hollows between the ribs; divergence of the lower and convergence of the upper ribs; comparative immobility; elevation of the shoulder; widening of distance between the nipple and the median line; depression of the liver, and removal of the heart from

its normal position. Fluctuation is occasionally appreciable. This collection of signs incident to enlargement of the chest, may, however, to a considerable extent, be reversed, in combination with flatness on percussion over the greater part of the chest. Absorption of the liquid effusion, inducing contraction, may take place, but not sufficiently to permit a return of percussion-resonance, with reappearance of respiratory sound, vocal resonance, and fremitus. Then, in connection with diminished size of the affected side, there will be convergence of the lower ribs, and divergence of the upper; depression of the shoulder, and narrowing of the distance between the nipple and the median line. Obliteration of the intercostal hollows and comparative immobility will be likely to continue.

Flatness on percussion may accompany abundant tuberculous deposit, the second stage of pneumonitis, and other affections involving abnormal density of the pulmonary substance. The facts pertaining to correlative signs which have been stated under the head of diminished resonance, or dulness, incident to pulmonary solidification, will be equally applicable, and need not be repeated.

4. Tympanitic Resonance.—The signs associated with the different varieties of tympanitic resonance differ widely, according to the diversity of anatomical conditions represented. In the affection which presents, more than any other, a resonance purely tympanitic, strongly marked and diffused, viz., pneumo-hydrothorax, the correlative phenomena derived from auscultation are, the characteristic vocal, tussive, and respiratory sign, metallic tinkling; feebleness or extinction of the vesicular murmur; blowing and amphoric respiration, occasional and irregular; absence of vocal resonance. Inspection and mensuration furnish the group of appearances incident to enlargement from liquid effusion. Palpation discloses absence or marked diminution of the normal vocal fremitus. Succussion developes the sign incident almost exclusively to this affection, viz., splashing.

Tympanitic resonance, circumscribed in extent at the summit of the chest, sometimes metallic or amphoric, and occasionally presenting a cracked-metal modification—these circumstances denoting its connection with a spacious pulmonary cavity, superficially situated, with rigid walls and free from liquid contents—exists in combination with cavernous respiration, presenting sometimes an amphoric intonation, alternating with gurgling; occasionally splashing, with the act of coughing, and metallic tinkling; pectoriloquy in some instances;

local depression or flattening at the summit of the chest, and deficient expansibility.

Occurring, as an exception to the general rule, over lung solidified by inflammatory exudation, it is combined, of course, with the various phenomena incident to that anatomical condition.

When presented in pleurisy, situated above the level of the liquid effusion, and also over the healthy lung in cases of pneumonitis, it cannot be said to have any definite correlative signs, irrespective of those which pertain to the diseases of which it is an incidental feature.

SIGNS CORRELATIVE TO SOUNDS FURNISHED BY AUSCULTATION.

1. INCREASED INTENSITY OF VESICULAR MURMUR.—Proceeding always from hyper-activity of respiration induced supplementarily in a portion of the pulmonary apparatus, the correlative signs are exaggerated percussion-resonance, and increased respiratory movements. The remarks made under the head of Exaggerated Vesicular Resonance are here equally applicable.

2. DIMINISHED INTENSITY OF VESICULAR MURMUR.—The phenomena associated with this sign are quite opposite in their character, corresponding to differences in morbid conditions which present a contrast equally striking.

Abnormal feebleness of the vesicular murmur may be due to the removal of the lung at a certain distance from the thoracic wall. This removal is caused by the presence, in some cases, of air or gas; in others, by a stratum of liquid or solid matter, and sometimes by air and liquid together, in the pleural cavity. In the first instance, a correlative percussion-sign is tympanitic resonance; in the second instance, it is absence of resonance, or flatness; and in the third instance, both are conjoined, *i. e.* tympanitic resonance exists above the level of the liquid, and flatness below this level. The presence of air and liquid, constituting pneumo-hydrothorax, is, however, very rarely characterized by simple feebleness of the respiratory sound; either the latter is abolished, or presents the cavernous or amphoric modification. Correlative signs incident to this affection are metallic tinkling and a succussion-sound. Diminution of the respiratory motions, of vocal resonance, and fremitus, are common to the three morbid conditions just mentioned.

Again, feebleness of respiration, without change in quality or rhythm, occurs in a certain proportion of cases of solidification from tubercle, inflammatory exudation, œdema, etc. On the other hand, it is incident to emphysema, bronchitis, and partial obstruction at any point in the air-passages. In these two classes of morbid conditions the correlative percussion-signs are precisely reversed. In the first class it is combined with diminished resonance, or dulness; in the second, the clearness of the percussion-sound is either undiminished or exaggerated. The anatomical condition in both instances is marked by the combination. Exclusive of the cases in which the lung is removed by liquid or solid matter, air, or gas, from the thoracic wall, feebleness of the respiratory murmur, combined with dulness on percussion, as the rule, denotes increased density of the pulmonary organ; combined with normal resonance, it indicates that the density is neither increased nor diminished; combined with exaggerated resonance, it is evidence of the abnormal rarefaction of the lung, pertaining to emphysema and some cases of bronchitis. Other signs existing in combination serve to establish the distinction as respects the anatomical condition. In cases of solidification, in which the effect on the respiratory sound is simply to diminish its intensity, the vocal resonance may be exaggerated, and even bronchophony may be present. In cases of rarefaction, this occurs only as rare exceptions to the general rule. The same remark will apply to vocal fremitus. Diminished respiratory motions may accompany both anatomical conditions. Enlargement of the chest, and its attendant phenomena, determined by inspection, mensuration, and palpation, pertain to emphysema. Diminished elasticity of the thoracic walls belongs to the former anatomical condition (increased density); increased elasticity to the latter (rarefaction).

3. SUPPRESSED RESPIRATION.—Abolition of the sound of respiration, occurring in connection with the same diversity of morbid conditions as diminished intensity of the respiratory murmur, presents similar combinations with other signs.

Accumulation of liquid or gas, or both air and liquid, within the pleural sac, in sufficient quantity to render respiration inaudible, gives rise, in the first instance, to flatness on percussion; in the second instance, to tympanitic resonance; and in the third instance, to tympanitic resonance above and flatness below the level of the liquid. Diminished respiratory movements, together with absence of vocal resonance and fremitus, are common to the three morbid conditions, and, in addition, first in the order of time, are presented the phenomena attending enlargement of the chest, which need not be again enumerated; and, second, the reversed phenomena following absorption of the fluid, sufficient to induce contraction, but not to permit reappearance of the respiratory sound.

In the cases of solidification from tubercle, inflammation, œdema, etc., in which suppression occurs, it is combined with notable dulness on percussion, as the rule, and with a clear tympanitic resonance, as an exception to the rule. Exaggerated vocal resonance, or bronchophony, and increased vocal fremitus, may exist in combination, together with diminished respiratory movements. On the contrary, in the cases of emphysema, in which the respiratory sound is lost, exaggerated percussion-resonance, with more or less of the tympanitic quality (vesiculo-tympanitic resonance), is the associated sign as the rule, dulness being observed, as an exception to the rule, in some instances in which the tension of the thoracic wall, from distension, is very great. In the former anatomical condition (solidification), the elasticity of the parietes of the chest is notably diminished; in the latter (rarefaction), the elasticity is increased. In connection with the suppressed respiratory sound incident to emphysema, the vocal resonance and fremitus are not exaggerated, save in some rare exceptional instances, the reverse being true, as already mentioned, of solidification.

4. Bronchial Respiration.—The bronchial respiration represents solidification of lung, except when it occurs in connection with dilated bronchial tubes, increased density of the pulmonary parenchyma, in the latter case, being superadded. The correlative signs, therefore, are those which have direct relation to pulmonary solidification, as it exists more especially in tuberculosis and pneumonitis, the bronchial respiration being much oftener present and more strongly marked in these, than in other affections in which the density of the lung is increased, viz., œdema, extravasation of blood, etc. The group of signs has been already given in connection with diminished vesicular percussion-resonance, and diminished or suppressed vesicular murmur, when these signs are due to the same anatomical condition, *i. e.* solidification. The associated signs, when the bronchial respiration exists, are much more uniform than those presented in combination with dulness or flatness on percussion, or with suppressed or diminished respiration, owing to the fact, that the anatomical condition represented, in the vast majority of instances, by the bronchial respi-

ration, is the same, while the signs last mentioned are incident to anatomical conditions different, and, indeed, opposite, in their character. Dulness on percussion, exaggerated vocal resonance, or bronchophony, increased vocal fremitus, diminished respiratory movements, increased force of resistance to pressure, are the signs sustaining a correlative relation to the bronchial respiration.[1]

5. BRONCHO-VESICULAR RESPIRATION.—Representing slight or moderate increase of the density of lung, the correlative relations of this modification of the respiratory sound, are essentially similar to those belonging to the bronchial respiration. The difference is, the signs which may be associated are less frequently present, and, when present, are less marked. Dulness on percussion is comparatively slight, and may not be appreciable; the vocal resonance and fremitus may not be obvious, and, if apparent, are weak; the respiratory movements are, perhaps, not sensibly diminished, or, if so, in a small degree; and impairment of the elasticity of the thoracic walls is either not determinable, or feeble.

6. CAVERNOUS AND AMPHORIC RESPIRATION.—Correlative cavernous signs form a group, each preserving always its significance, and not occurring in connection with other anatomical conditions. Actually, however, they are rarely combined, and, indeed, it is impossible for all of them to be present simultaneously, since some can only be produced when the cavity is empty, and others only when it is more or less filled with liquid. The correlative signs requiring an empty space, are the cavernous respiration, pectoriloquy, and circumscribed tympanitic percussion-resonance, inclusive of the metallic modification, and the cracked-metal sound. The correlative signs requiring the presence of liquid, are circumscribed dulness on percussion, gurgling, splashing with the act of coughing, and occasionally metallic tinkling. The two series of signs may occur in alternation. Both are incident to pulmonary cavities, tuberculous or otherwise, inclusive of pouch-like dilatation of the bronchial tubes; and, also, in the

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[1] Under the head of Correlation of Physical Signs, I design to embrace only those which sustain toward each other direct relations. The signs incident to pleuritic effusion in the instances in which bronchial respiration exists over the compressed lung, are indirectly related, and therefore, not included among those to which the term correlative is applied. For the same reason, I do not enumerate among correlative signs those supplementarily induced by various affections in parts of the lungs more or less remote from the situation of the disease.

pleural space, in connection with perforation, or, in other words, in pneumo-hydrothorax. In the latter affection, the cavernous respiration oftener presents the amphoric character; and the associated signs differ from those pertaining to pulmonary cavities. The percussion-resonance is more constantly tympanitic, is not circumscribed, but more or less diffused. Liquid, in greater or less quantity, is always present, and hence, flatness coexists with tympanitic resonance, the former situated above, and the latter below the level of the liquid. Metallic tinkling is generally observed, while in pulmonary cavities it is of rare occurrence. The succussion-sound is common, which is exceedingly infrequent in cavities formed within the lungs. The phenomena attendant on enlargement of the chest, are generally present in cases of pneumo-hydrothorax, and absent in intra-pulmonary excavations.

7. ADVENTITIOUS RESPIRATORY SOUNDS, OR RALES.—The adventitious sounds, or rales, may be considered under one heading, for, excepting a single species, viz., gurgling, they resemble each other in not sustaining toward other signs any fixed correlative relations. In this respect, they offer a striking contrast to the signs already enumerated. The moist and dry bronchial rales, including the sub-crepitant, generally represent pulmonary catarrh or bronchitis. They constitute all the positive or direct physical signs belonging to these affections. Other signs, it is true, are frequently found associated with them, but in such instances, pulmonary catarrh or bronchitis are superadded to other affections. The connection is one of coincidence, not of a pathological relation. This deficiency of correlative signs has a positive and important bearing on diagnosis. The presence of the bronchial rales, taken in connection with the absence of abnormal percussion-sound, or other signs, establishes the existence of the diseases which they represent, disconnected from other affections. The crepitant rale represents, in the great majority of the instances in which it is observed, pneumonitis. Pneumonitis during its career presents, as has been seen, a group of correlative signs; but the crepitant rale, strictly speaking, cannot be considered to stand in a correlative relation to any of them, for it is developed often prior to their appearance, and although it very frequently persists after other signs have appeared, this is by no means uniformly the case. Moreover, in a certain proportion of cases, it does not appear during the course of the affection. In the instance of this disease, as of bronchitis, the

absence of coexisting signs is an important point, for, in connection with certain symptoms, it may denote the existence of pneumonitis, not advanced sufficiently to give rise to the pathological changes represented by associated signs. This point may have a material influence on the therapeutical management of the disease. The indeterminate rales, although often combined with other physical phenomena, and deriving much of their diagnostic significance from the combination, have, nevertheless, no fixed or definite correlative signs. In other words, there are no signs involving the coexistence, even in a considerable proportion of instances only, of the indeterminate rales.

8. Friction-Sounds.—These resemble the foregoing rales in not sustaining definite correlative relations to other signs. They differ, however, in this respect, viz., clinically, they are very rarely found isolated; they are associated with signs to which they do not stand in a fixed or uniform relation. The associated signs are different, according to the different circumstances under which the friction-sounds are developed. Representing, in the great majority of instances, pleuritis, they may or may not be associated with the physical evidences of a certain amount of liquid effusion. Occurring either at the commencement or at a late period in the career of the disease, they may or may not be accompanied by the phenomena pertaining to contraction of the chest. Being incident not only to simple pleurisy, but occasionally to pleurisy developed as a complication of tuberculosis and pneumonitis, they may be found in combination with the groups of the physical signs representing the latter affections.

PART II.

DIAGNOSIS OF DISEASES AFFECTING THE RESPIRATORY ORGANS.

PART II.

DIAGNOSIS OF DISEASES AFFECTING THE RESPIRATORY ORGANS.

PRELIMINARY REMARKS.

The diagnosis of diseases affecting the organs of respiration inolves the practical application of the principles which it has been e object, in the preceding pages, to elucidate. In the investigaon of diseases, however, at the bedside, the attention is by no eans to be directed solely to signs. Invaluable as they are, their portance is greatly enhanced by association with symptoms and e knowledge of pathological laws. The results of physical exploraon alone, frequently leave room for doubt, and liability to error, hen a due appreciation of vital phenomena and of facts embraced in e natural history of diseases, insures accuracy and positiveness. n overweening confidence in the former is to be deprecated as well exclusive reliance on the latter. And since the practical discrimiation of intra-thoracic affections is always to be based on the comined evidence afforded by these three sources of information, in eating of the subject, it is desirable that the attention shall not be mited to one source to the exclusion of the others. In taking up, erefore, in the succeeding pages, the diagnosis of individual diseases, shall not disconnect entirely physical signs from symptoms and athological laws. After premising a few considerations, the signs elonging to each disease will be considered; and under the head of *iagnosis* I shall adduce symptoms and pathological laws which are be associated with the phenomena furnished by physical exploration the discrimination of the disease. The diseases affecting the spiratory organs, may be distributed according to their proximate natomical relations into the following groups: 1. Those affecting he bronchial tubes; 2. Those more immediately connected with the ir-cells and pulmonary parenchyma; 3. Those seated in the pleura. shall take up the particular diseases embraced in these three groups, the order just enumerated. Diseases affecting the trachea and rynx will form a fourth group.

CHAPTER I.

BRONCHITIS—PULMONARY OR BRONCHIAL CATARRH.

Bronchitis, or inflammation of the mucous membrane lining the bronchial tubes, admits of being divided, nosologically, into two forms, the distinction being based on difference in seat. In one form, the inflammation is confined to the larger subdivisions of the bronchi; in the other form, it is either restricted to the minute branches, or more commonly affects them and the larger subdivisions also. In the great majority of cases the disease is presented in the first form, and, consequently, this may be distinguished as *ordinary bronchitis.* The second form is generally called *capillary bronchitis.* This title implies that the inflammation is seated in the capillary bronchial tubes, which is not the fact; the smaller ramifiçations are affected, but not the terminal twigs of the bronchial tree, or bronchioles, which are, properly speaking, the capillary tubes. This form offers striking peculiarities as regards symptoms, physical signs, and pathological laws.

Another division, based on the duration and degree of the inflammation, is into *acute* and *chronic* bronchitis.

The inflammation may be developed in the bronchial tubes as a primitive, idiopathic affection; and it may coexist with other diseases, seated either in the pulmonary organs, or elsewhere. Important points of difference pertain to this distinction.

The affection may be general; in other words, invading the bronchial tubes to a greater or less extent on both sides; and it may be partial or circumscribed, in the latter case occurring almost invariably as a complication of some other antecedent pulmonary disease.

Farther divisions were formerly made, based on the predominance of certain symptoms, for example, the quantity and quality of the liquid products expelled from the bronchial tubes. By writers of the present day, these differences, although constituting important modifications of the disease, are deemed insufficient grounds for multiplying nosological distinctions. The occurrence of a plastic or fibrinous exudation on the mucous surface, however, is a peculiarity sufficiently striking and important to serve as the basis of a distinct variety.

In treating of bronchitis with reference to its diagnosis, I shall consider under separate heads the following divisions:

1. Acute bronchitis. Under this head I include cases in which the disease, in addition to its acuteness, is idiopathic, and limited to the larger subdivisions; in other words ordinary, and primary acute bronchitis.
2. Capillary bronchitis.
3. Pseudo-membranous or plastic bronchitis.
4. Chronic bronchitis.
5. Secondary bronchitis.

ACUTE BRONCHITIS.

The circumstances pertaining to the anatomical characters of acute bronchitis, which stand in immediate causative relation to the development of the characteristic physical signs are, unequal diminution of the calibre of the affected tubes, from swelling or thickening of the membrane, and more especially, from the presence of tenacious mucus; the presence or absence of liquid in the tubes; the quantity when present; the facility with which it is moved from place to place, and permeated by air; the size of the tubes, among those of large or medium dimensions, in which the disease and its products are chiefly situated; obstruction, temporary or persisting, of some of the tubes, diminishing or cutting off the supply of air to the vesicles to a greater or less extent, and sometimes condensation of pulmonary lobules proportionate to the number and size of the obstructed tubes.

Physical Signs.—Percussion, in general, furnishes no positive signs in bronchitis, but negatively the information which it affords is of greater practical importance than any of the positive signs pertaining to the disease. Clearness of the percussion-resonance is a fundamental point in the diagnosis. As the rule, it holds good that the resonance continues vesicular and undiminished, and it is sometimes increased. The exceptions to this rule are very infrequent. Moderate dulness, situated at the posterior and inferior part of the chest, has been observed as the result of the accumulation within the bronchial tubes of the liquid products of inflammation, toward the close of the disease in fatal cases characterized by an abundant secretion of these products. Collapse of portions of the lung from obstruction of certain of the tubes may also give rise to dulness. These exceptions do but little toward invalidating the rule. In the vast majority of the instances in which the resonance on percussion is found to be diminished, the bronchial affection is a complication of some other pulmonary disease. The existence of bronchitis having been determined by symptoms, laws, and positive signs, the fact of the percussion-sound remaining clear serves to establish its idiopathic character.

With an unimportant exception, auscultation furnishes all the positive physical signs of bronchitis. These consist of the dry and moist bronchial rales. During the early part of the disease, so long as the matter of the expectoration is slight and adhesive, the rales are dry, generally sonorous, but sometimes approximating to the sibilant. The moist or mucous rales follow, when the liquid contained in the bronchial tubes becomes more abundant and less viscid. Both description of rales may be afterward commingled in varied proportions. The varieties of the dry and moist rales, with their distinctive fluctuations as respects intensity, persistency, etc., have been already fully described, and it is unnecessary to reproduce in this connection details relative to these points. It will suffice to mention the following practical considerations. The dry rales alone do not constitute adequate proof of the existence of bronchitis, for contraction of the bronchial tubes from spasm, with, and even without, simple irritation of the mucous membrane, suffices for their production. Nor do bubbling rales, of themselves, invariably denote the disease, for they may proceed from blood, pus, as well as serum and mucus, within the tubes, without necessarily involving bronchial inflammation. If, however, the two classes of sounds occur in succession, or if they are found to be commingled, the diagnostic evidence either of bronchitis or bronchial catarrh is complete, but whether primary or secondary is to be determined by other signs.

The occurrence of moist rales succeeding the dry, is in general to be considered evidence of the progress of inflammation toward resolution.

The combination of dry rales of different grades as respects pitch, in other words, the grave tones of the sonorous rale accompanying expiration, united with sounds approaching in acuteness the sibilant rale, the latter heard especially with inspiration, render it probable that the bronchial inflammation extends over a considerable area, embracing the smaller bronchial subdivisions. This conclusion is also warranted by the combination of the coarse and fine varieties of the moist or bubbling rales. Another indication of the extent of the bronchial tree affected, is afforded by the diffusion of the rales over the chest. If the inflammation be confined to the larger tubes, the rales will be found to originate within a section corresponding to the middle third in front and behind; if they emanate from the upper and lower thirds, the fact shows that the inflammation extends beyond the larger tubes.

Absence of the rales is by no means proof that bronchitis does not exist. Both the dry and moist bronchial rales are evanescent and variable. They may be absent at one examination and present at the next; or they may disappear and reappear during the same examination. The different varieties may be presented in succession, alternation, and in varied combinations. These diversities have been already described. But repeated explorations, in some cases of bronchitis, fail to discover any of the positive auscultatory signs. The physical conditions necessary for the production of the rales may not exist, or be present irregularly, and for brief periods, and thus they escape observation.

The loudness of the rales and their constancy are not commensurate with the intensity or extent of the bronchial inflammation. The physical conditions requisite for the production of the dry and moist rales, may be present in a more marked degree in certain cases of mild bronchitis, than in other cases in which the disease is severe. A little reflection in connection with the mechanism of the production of these rales, will render the fact just stated intelligible.

Finally, a highly important practical consideration is, the rales incident to idiopathic bronchitis are heard on both sides of the chest. The law of symmetry pertaining to this disease is often useful in the diagnosis, and hence, the value of the physical signs of the existence of the bronchial inflammation on the two sides.

The vesicular murmur is frequently obscured, or even drowned by the bronchial rales. At the commencement of the disease, before the dry rales are developed, the murmur is frequently abnormally loud, the expiration being somewhat prolonged, as in exaggerated respiration; the sound is also rough or harsh. This increased intensity and roughness of quality may persist, if the characters of the vesicular respiration are not masked by the presence of the rales. These modifications of the respiratory murmur are observed especially at the superior portion of the chest. In some cases of bronchitis the murmur is heard throughout the continuance of the disease, apparently not materially modified as respects either its intensity or character. This is true of certain cases in which the inflammation is not severe, confined to the larger tubes, unaccompanied by much swelling of the membrane, and the secretion of mucus slight. The vesicular murmur is diminished oftener than exaggerated during the progress of bronchitis, and not unfrequently it is suppressed partially or generally over the chest. Partial suppression may be caused by plugging of certain of the larger bronchial tubes with tenacious mucus, interrupting the passage of air sufficiently to abolish sound. In this way bronchial rales, as well as the vesicular murmur, beyond the seat of the obstruction, may be arrested. Situated in the primary or secondary divisions of the bronchi, the interruption to the passage of air may cause suppression over a considerable portion of the chest. It is conceivable, indeed, that the quantity and force of the current of air received by inspiration may be diminished by the adherence of the tenacious products of inflammation to the surface of the larger tubes of both lungs, so as to abolish universally respiratory sound, and yet the obstruction not be great enough to occasion marked dyspnœa. That partial suppression is frequently due to this cause, is shown by the vesicular murmur being suddenly developed after an act of coughing, in a portion of the chest where just preceding this act it had not been appreciable,—a fact often observed in auscultating patients affected with this disease. This suggests a procedure which should be resorted to, in order to determine whether the diminution or suppression proceed from the presence of liquid products, viz., requesting the patient to make a voluntary effort of coughing, and auscultating immediately afterward. If the respiratory sound, with or without rales, reappear, or become more intense in a situation where, prior to the act of coughing, it was either absent or feeble, the result shows that the diminution or suppression proceeded from a movable cause of obstruction. The result may follow an act of coughing without expectoration, the collection of mucus being detached and thrown forward into tubes of larger size, to be subsequently expectorated. The tumefaction and thickening of the mucous membrane may be sufficient to diminish, and even abolish, the vesicular murmur, in cases in which the inflammation extends to the smaller bronchial tubes. Marked diminution or suppression of respiratory sound generally over the chest, under these circumstances, is evidence of the extent of the bronchial inflammation. The emphysematous dilatation of the air-cells is another circumstance tending to enfeeble the vesicular murmur.

As regards the other methods of exploration, inspection and palpation enable us to ascertain whether the respiratory movements are morbidly frequent, or abnormally modified. In the form of bronchitis under present consideration, the frequency of the respirations is rarely more than moderately increased, and usually they are not notably labored or attended by dyspnœa. The superior and inferior costal types of breathing are frequently somewhat more developed than in health. On applying the hand to the chest a vibration or fremitus may in some instances be felt, which is incident to the bronchial rales, and called the rhonchal fremitus. This is of little practical importance, inasmuch as it affords no information in addition to that obtained more satisfactorily by auscultation.

Diagnosis.—The diagnosis of acute bronchitis, with the aid of physical exploration, is generally unattended with difficulty. Prior to the discovery of auscultation, it was confessedly impracticable, in many instances, to discriminate between inflammations affecting the mucous, serous, and parenchymatous structures. The application of physical signs having rendered this discrimination easy and positive in the great majority of cases, has thereby contributed to the more successful study of the semeiological history of these different affections ; so that at the present time, the diagnostic importance of symptoms and pathological laws is much better understood than previously. Yet, even now, cases not infrequently present themselves of which the diagnosis would be difficult and uncertain without the aid of exploration. Cases of pneumonitis and pleuritis are occasionally wanting in their most distinctive symptomatic phenomena; and, on the other hand, cases of bronchitis are sometimes equally deficient in its peculiar features. The differential diagnosis, under these circumstances, must rest mainly on physical signs. But in cases of a less doubtful description than those just supposed, the physical signs enable the physician to discriminate with greater promptness, ease, and confidence, as well as with much less actual liability to error, than if he relied exclusively on the symptoms. So far as the results of exploration are concerned, the discrimination of idiopathic bronchitis from pneumonitis and pleurisy involves, first, undiminished resonance on percussion on both sides. In pneumonitis and pleuritis, as will be seen hereafter, dulness or flatness occurs on one side soon after the invasion. In bronchitis, the air-vesicles remaining filled with air, and sometimes even abnormally distended, the percussion-sound retains its normal clearness, while in pneumonitis the presence of solid matter within the vesicles, and in pleuritis the presence of liquid in the pleural cavity, diminish or abolish the resonance. Second: the bronchial rales, generally but not invariably present to a greater or less extent in bronchitis, exist on both sides of the chest. Bronchitis may complicate both pneumonitis and pleurisy, but the two latter affections being confined to one side in the vast majority of instances, the bronchial rales are manifested chiefly on the affected side. On the other hand, idiopathic or primary bronchitis is a symmetrical disease, and the bronchial rales when present are generally heard on both sides. It is in this way that the law of symmetry has an important bearing on the diagnosis. Third: in uncomplicated bronchitis certain distinctive physical signs present in cases of pneumonitis and pleuritis are absent. This point, like the first, is essentially negative, but its bearing on the diagnosis is quite positive. In pleuritis, auscultatory and other signs of liquid in the pleural sac, are readily appreciable. In pneumonitis, the evidence, other than that furnished by percussion, of solidification of lung, together with the characteristic rale (the crepitant), are generally available. Hence, absence of the physical phenomena which characterize these two affections warrants their exclusion.

Lobar pneumonitis, the ordinary form of the disease in the adult, is referred to in the foregoing remarks. The form occurring in young children, viz., lobular pneumonitis, in which the inflammation attacks isolated pulmonary lobules on both sides, is habitually associated with bronchitis, and hence called broncho-pneumonia. The diagnostic marks by which broncho-pneumonia is distinguished from simple bronchitis are much less distinctly defined than those which contrast it with lobar pneumonitis. The discrimination is in fact not always easy. Evidence derived from physical exploration is incomplete, owing to the positive signs of pneumonitis being generally wanting or imperfectly developed in this form of the disease. Symptoms are more to be relied upon than signs. And the symptoms indicating lobular pneumonitis in connection with bronchial inflammation, are those which show the respiratory function to be compromised to a greater extent than is usual in cases of uncomplicated bronchitis, viz., frequency of the respirations; dilatation of the alæ nasi; lividity of prolabia, etc. If in connection with the local symptoms of ordinary bronchitis, the respiration be but little accelerated, the alæ not dilated, the blood properly oxygenated, and the physical signs of pneumonitis not discoverable, the affection may be considered to be simply bronchial inflammation; but if, in connection with the same local symptoms, the respirations are hurried, the alæ dilating, the blood imperfectly oxygenated, even with the absence of the characteristic signs of pneumonitis, the disease nevertheless may be broncho-pneumonia. The absence of the signs which are characteristic of lobar pneumonitis, viz., the crepitant rale, relative dulness of percussion-sound on one side, bronchial respiration, bronchophony, and exaggerated fremitus, do not authorize the exclusion of lobular pneumonitis, because all these signs may be wanting in cases of the latter form of the disease. But this subject will be considered more fully in connection with the diagnosis of broncho-pneumonia. In the suppositions just made, an important qualification is introduced. It is assumed that the bronchitis is of the ordinary form; in other words, that the inflammation does not extend to the minute bronchial branches. General capillary bronchitis compromises the respiratory function to a greater extent than broncho-pneumonia; and hence, great frequency of the respirations, dilatation of the alæ, and lividity, may indicate the former, instead of the latter affection. The differential diagnosis of these affections, however, will present itself for consideration more appropriately hereafter.

The liability of confounding tuberculosis of the lungs with bronchitis, relates rather to the chronic than the acute form of the latter affection. In some cases of acute phthisis, the abrupt invasion and rapid progress of the disease, may lead the physician, at first, to suppose that he has to deal simply with acute bronchitis. With due investigation this error should be avoided. The fact of acute bronchitis being preceded, in a large proportion of instances, by inflammation or irritation of the air-passages above the trachea, has some bearing on this discrimination. In tuberculosis, the symptoms from the first are oftener pulmonary. The coincidence of acute bronchitis and the development of tuberculous disease occurs in only a small proportion of cases. Hence, if an acute pulmonary affection have been ushered in by catarrh, or coryza, gradually advancing downward to the pulmonary organs, the presumption is in favor of its being simple bronchitis. Other points of difference are entitled to vastly more weight than that just stated. Acute tuberculosis is frequently ushered in by hemorrhage. This does not occur in bronchitis, excepting the bloody streaks with which the sputa are occasionally marked. The pain in bronchitis is substernal, and is dull, obtuse, or burning in character. Tuberculosis is characterized by sharp, lancinating pain, situated at the summit of the chest on one side, frequently under the scapula. The pulse in acute phthisis, accompanied by continuous fever, is accelerated out of proportion to the local pulmonary symptoms, which indicating or simulating bronchial inflammation. The reverse is true of acute bronchitis. The respirations are more frequent in acute phthisis than in ordinary bronchitis, the loss of strength is notably greater, and the emaciation more rapid. The physical signs establish conclusively the differential diagnosis in the great majority of cases of tuberculosis. percussion reveals a disparity between the two sides, the dulness being almost always at the upper portion of the chest. This will be associated with more or less of the auscultatory signs of solidification. The bronchial rales denoting coexisting bronchitis are especially marked on one side, and at the summit in front, while in uncomplicated bronchitis they are especially heard over the base of the lungs, on the posterior surface of the chest. The question, in cases of acute phthisis, whether the disease be simply bronchitis, can only arise for a short period after the invasion, for in the progress of the disease unmistakable evidence of its character is soon developed, and even of that afforded by physical exploration.

Acute ordinary bronchitis occurring in a person affected with emphysema, gives rise to embarrassment of the respiration and dyspnoea, out of proportion to the extent and intensity of the bronchial inflammation. Without knowledge of the coexistence of emphysema, the symptoms would lead to the suspicion of an acute affection other than ordinary bronchitis, for example, pneumonia or pleurisy, the distinctive symptoms which characterize these affections being absent. The history and physical signs enable the physician readily to determine the associated morbid condition which invests the acute bronchitis with such unusual symptoms; but to point out the mode of arriving at this conclusion, would be to anticipate the consideration of the diagnosis of emphysema, to which a distinct chapter will be devoted.

Bronchitis, unassociated with other pulmonary disease, occurs as a pathological element of certain general affections, more especially fevers. It forms an important constituent, in a pretty large proportion of cases of rubeola ; and being present in a greater or less degree frequently in typhus and typhoid fevers, it may constitute a prominent feature of these affections. There is a liability, under these circumstances, to consider the disease simply and exclusively bronchitis. In rubeola, the bronchial symptoms preceding for several days the appearance of the eruption, this error does not necessarily imply want of care or skill on the part of the diagnostician. The chief distinguishing points are the degree and persistency of the coryza, the irritation or inflammation extending along the lacrymal passages to the conjunctiva, and the disproportion between the local evidences of bronchitis and the general symptoms, such as febrile movement, pain in head and loins, loss of appetite, etc. These points, however, are not infrequently unavailable; and, in fact, in a certain proportion of cases, it is difficult, if not quite impossible, to predict with positiveness that the affection will prove to be more than bronchitis. In continued fever the difficulty is less, and, indeed, with due attention and knowledge, it should rarely exist. Except in some occasional instances, continued fever is not ushered in by marked symptoms of a bronchial affection; these symptoms become developed after the fever is confirmed. The disease has a prodromic period, in which usually other phenomena are more prominent than those pertaining to the pulmonary organs. Limiting the attention to typhoid fever, the form of continued fever generally observed in this country, and the form in which the bronchial element is oftener marked, the duration of the stage of invasion and the characteristic symptoms frequently present in this stage, suffice for the diagnosis. Afterward, in addition to the characters then present denoting the disease, viz., the abdominal symptoms, epistaxis, eruption, etc., the pulmonary affection compared with the febrile movement, the prostration, anorexia, etc., is disproportionately mild. The rales observed are the sonorous and sibilant, more especially the latter ; and these continue, rarely merging into, or becoming combined with, the mucous rales. The facility with which the discrimination is made, in the vast majority of cases, renders it superfluous to dwell longer on the details of the differential diagnosis.

SUMMARY OF THE PHYSICAL SIGNS BELONGING TO ACUTE ORDINARY BRONCHITIS.

Percussion-resonance clear on both sides of the chest. In the early stage, before liquid secretion takes place, the dry rales, especially the sonorous, irregularly present in a certain proportion of cases. After secretion, the moist rales frequently commingled with the dry. The rales heard on both sides. The respiratory murmur at the upper portion of the chest in front exaggerated and harsh in the early stage. Subsequently liable to be diminished or suppressed over a part or the whole of the chest. Sometimes reproduced suddenly after an act of coughing. In some mild cases preserving its normal intensity and characters. A rhonchal fremitus occasionally present.

CAPILLARY BRONCHITIS.

Bronchitis is distinguished as capillary, when the inflammation invades the minute bronchial branches. Inflammation of the larger tubes generally, but not uniformly, coexists. The capillary tubes or bronchioles, in other words, the terminal subdivisions, are not necessarily implicated. Extending to the latter, and limited to more or less of the pulmonary lobules, the affection called broncho-pneumonia is superadded. Capillary bronchitis was formerly described by medical writers under the titles, peripneumonia notha, and suffocative catarrh. Its true character and seat have been but recently understood. It is with great propriety considered to be a distinct form of bronchitis, differing from the ordinary form in important particulars, pertaining to symptoms, laws, and signs, as well as to anatomical characters.

The anatomical conditions, on which the physical signs are immediately dependent, are, irregular contraction of the calibre of the minute tubes, the presence of liquid within these tubes, and obstruction to the passage of air to and from the vesicles. The latter condition, *i. e.* the obstruction, is that to which the most distinctive and important symptoms stand in immediate relation.

Physical Signs and Diagnosis.—In capillary, as in ordinary bronchitis, the air within the pulmonary vesicles remaining undiminished, and, indeed, increased in quantity (excepting the reduction due to the collapse of lobules, which takes place, to a greater or less extent, in a certain proportion of cases, the percussion-resonance is unimpaired, and acquires an exaggerated clearness, especially at the superior and anterior portion of the chest. A clear sound on percussion, and equal on the two sides, although negative, is a fundamental point in the diagnosis. Dulness denotes either that the affection is complicated with pneumonitis, or that a certain amount of collapse has taken place.

Auscultation furnishes, at the early part of the disease, and to a greater or less extent during its career, the dry bronchial rales. Both the sonorous and sibilant are incident to this variety of bronchitis, but the latter is characteristic of extension to the minute tubes. The sibilant rale is sometimes in a marked degree acute or whistling in its character. The sonorous rales may be loud and musical, as in cases of asthma, being appreciable by the patient himself and by others. Both varieties are generally diffused over the whole chest. The presence of the rales tends to drown the vesicular murmur, but the latter is rendered feeble, and may be abolished by the obstruction within the tubes, and the over-distension of the cells. The moist or mucous rales incident to ordinary bronchitis may be present, more or less, depending on the inflammation of the larger tubes, which usually coexists, and the amount of the consequent mucous secretion. But a moist rale characteristic of an affection of the minute tubes is the *sub-crepitant.* This rale in its sensible characters, as well as in its source, holds an intermediate place between the mucous, on the one hand, and the crepitant (intra-vesicular), on the other hand. It is a bubbling rale, conveying to the ear the impression of the presence of liquid. The bubbles seem to be small, and somewhat unequal in size. The sound is finer than that of the finest mucous rales. It may accompany either inspiration or expiration, or both respiratory acts. Contrasted with the sub-crepitant, the crepitant rale is still finer; it is dry, *i. e.* not conveying the idea of bubbles, and in fact does not belong in the category of the bubbling rales; the crepitations are equal, and it is limited to the inspiratory act. These several points of distinction enable the auscultator to discriminate between the two in the majority of instances, by the sensible characters alone.[1] The law of symmetry here, as in the ordinary form of bronchitis, has an important bearing on the diagnosis. In conformity with this law the sub-crepitant rale is found on both sides of the chest. This is a point distinguishing it from the crepitant rale which, in the vast majority of cases, is limited to one side. It is true that, capillary bronchitis occurring generally in children, the discrimination is to be made between it and the lobular form of pneumonitis in which the inflammation affects both sides. But, as will be seen hereafter, in lobular pneumonitis the crepitant rale is rarely appreciable.

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[1] In a case of capillary bronchitis complicated with lobar pneumonitis in the adult, the sub-crepitant rale accompanied both respiratory acts, and the crepitant was distinctly appreciable at the end of inspiration.

The sub-crepitant rale in capillary bronchitis is heard especially over the lower third of the chest posteriorly. Present in this situation, diffused over a considerable space, on both sides, and the percussion-resonance unimpaired, this combination of signs in connection with the symptoms of the disease, renders the diagnosis positive. The sub-crepitant rale, under these circumstances, becomes pathognomonic. Aside from its connection with capillary bronchitis, this rale occurs in œdema of the lungs, in hæmoptysis, in some cases of phthisis, and in pneumonitis. But the associated signs and symptoms in all cases render it sufficiently easy to distinguish between these several affections and idiopathic capillary bronchitis. Œdema is a secondary affection, frequently limited to one side, and gives rise to dulness on percussion. In hæmoptysis, the bloody expectoration indicates the source of the sign, and hemorrhage (excepting the bloody streaks which the sputa occasionally present), does not belong among the events liable to occur in this, more than the ordinary form of bronchitis. In phthisis, the sub-crepitant rale is an occasional sign limited to a circumscribed space at the summit of the chest, and associated with more or less of the other signs, as well as with the symptoms denoting tuberculosis. In pneumonitis it occurs at a late stage of the disease, after the diagnosis has been determined, but the connection is easily established by the concomitant physical signs, viz., bronchial respiration, bronchophony, dulness on percussion, etc., these signs being, in the vast majority of cases, limited to one side of the chest.

If the practitioner were to be guided exclusively by the symptoms, he might be at a loss in some instances to decide between the existence of capillary bronchitis, and acute pneumonitis, or pleuritis, occurring in the adult, albeit the distinguishing features of the former, as contrasted with the two latter affections, are of a striking character. Acute pneumonitis and pleuritis are generally characterized by sharp, lancinating pains, which do not enter into the symptomatic history of capillary bronchitis. The latter, in the great majority of instances, supervenes either on ordinary bronchitis or pulmomonary catarrh. The former are preceded by an inflammatory or catarrhal affection of the bronchial mucous membrane in only a small proportion of cases. They are frequently ushered in by a chill, which is not observed to accompany the onset of capillary bronchitis. The suffering with orthopnœa, the cyanotic hue of the lips and surface, the great frequency of the pulse, the rapid progress frequently to a fatal issue, distinguish severe cases of capillary bronchitis; these symptoms not being present to the same extent, save in rare exceptional cases, of pneumonitis and pleuritis. But with the aid of physical exploration the discrimination is made with so little difficulty that it is not necessary to dwell on the subject. Both pneumonitis and pleuritis speedily present certain positive signs, so constantly present and so easily appreciated, that their absence warrants the exclusion of these affections. These signs are incident to solidification of the lung in pneumonitis, and the presence of liquid effusion in pleuritis. In the vast majority of instances they are confined to one side in both affections. On the other hand, the sub-crepitant rale, and the dry rales belonging to capillary bronchitis, are diffused universally over the chest. The fact, however, is not to be lost sight of, that capillary bronchitis may become complicated with lobar pneumonitis in the adult; and it is to be borne in mind that in these remarks the form of pneumonia peculiar to children (broncho-pneumonia) is not referred to.

An instance has fallen under my observation of acute phthisis in which the tuberculous deposit was so abundant and rapid as to induce great difficulty of respiration, accompanied with very rapid pulse, lividity of prolabia and face, and ending fatally by asphyxia within a fortnight. But in this case hæmoptysis occurred, and the physical signs denoted plainly tuberculous consolidation, most marked at the summit of the chest. In such an instance, an error of diagnosis could only befall one who depended entirely on symptoms.

Other diseases for which there is a liability of capillary bronchitis being mistaken, and *vice versa*, are, *first*, certain affections of the larynx, inducing the phenomena of asphyxia; and, *second*, certain pulmonary affections in addition to those already mentioned, viz., asthma, ordinary bronchitis in connection with emphysema, lobular pneumonitis, or broncho-pneumonia, and the variety of bronchitis to be next noticed, called plastic or pseudo-membranous.

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vesicular murmur; not the rales incident to capillary
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Spasm of the glottis, rare in the adult, but not uncommo
life, is a paroxysmal affection, the respiration, in the inter
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Laryngitis in the adult, and croup in children, present
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ference. The voice is hoarse, husky, or extinguished, while
remains unaffected in capillary bronchitis. Moreover, in
sonorous tubular breathing and cough are diagnostic. T
of the auscultatory signs of capillary bronchitis in both
tions, as in the foregoing instances, renders the diagnosis

A paroxysm of asthma is characterized by symptoms
those presented in capillary bronchitis. The orthopnœa and
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tion of the obstruction is the same, viz., in the minute
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[illegible]

frequency, and never is accelerated to the degree observed in capillary bronchitis.

Acute bronchial inflammation extending beyond the larger, but not to the minute branches, occurring in a person affected with emphysema, induces a train of symptoms resembling closely those of the capillary form of bronchitis. The suffering and labor with respiration, and the impaired oxygenation of the blood, may be equally marked, but the prognosis is far less grave. The existence of emphysema is readily determined by present signs taken in connection with the previous history. The sonorous and sibilant rales will be likely to be present in connection with the mucous rales, but not the subcrepitant. The coexistence of the emphysema renders the symptoms pertaining to the respiration and hæmatosis much less ominous than if this complication did not exist. The pulse, which, under these circumstances, is a better index of immediate danger than the symptoms just referred to, is less frequent than in capillary bronchitis.

Mild capillary bronchitis occurring in an emphysematous subject, gives rise to dyspnœa out of proportion to the actual amount of obstruction. Moreover, as such subjects are generally liable to asthma, spasm of the muscular fibres of the bronchial tubes is a more prominent element than in cases in which the capillary bronchitis is uncomplicated, and hence the difficulty of breathing is in a more marked degree paroxysmal. Under these circumstances the pulse denotes less intensity of inflammation and danger than might be inferred from the pulmonary symptoms alone. These facts, however, have relation to the prognosis, and the importance of active therapeutical interference, rather than to the diagnosis.

The affection with which capillary bronchitis is most likely to be confounded, and from which it is with most difficulty distinguished, is lobular pneumonitis or broncho-pneumonia. Both affections are peculiar to young subjects, and hence, occasions are oftener presented to the practitioner for discriminating between these, than between capillary bronchitis and the other form of disease, to which in some of its features it bears resemblance. Moreover, capillary bronchitis and broncho-pneumonia may actually be combined; and, in fact, the latter probably always involves inflammation of the minute bronchial branches in direct communication with the inflamed lobules. In capillary bronchitis, the inflammation extends from the larger to the minute bronchial tubes generally throughout the pulmonary organs, either with or without the air-cells of more or less of the lobules becoming implicated. In broncho-pneumonia, the inflammation extends from the larger tubes to a certain number of the air-cells of the lobules on each side, affecting, of course, the intermediate minute branches leading to the lobules which have become inflamed, but limited to these, and in this respect differing very materially from general capillary bronchitis. In both affections, ordinary bronchitis exists, with the symptoms and signs incident thereto. In both, the respirations are hurried, with more or less dyspnœa, and perhaps with evidences of defective hæmatosis.

In the lobular form of pneumonitis, as has been already stated, and as will appear more fully hereafter, the characteristic physical signs, as well as certain symptoms pertaining to lobar inflammation of the pulmonary parenchyma, are frequently wanting. The crepitant rale, the bronchial respiration and bronchophony, are often not discoverable. The matter of expectoration in young children is swallowed. In view of these facts, how is the differential diagnosis to be made? The following are the chief points of distinction. General capillary bronchitis, as a rule, is a graver affection than lobular pneumonitis; the respirations are more frequent; the asphyxiating effects are greater, and the symptoms representing these effects, viz., dyspnœa, restlessness, lividity, in a corresponding degree more marked. In fatal cases, the career of the disease is more rapid. With reference to physical signs, one source of difficulty is the incompleteness of the explorations with which the physician must be content in examining young children. With care and perseverance the characteristic phenomena of pneumonitis may, in some cases, be discovered. In addition to the auscultatory phenomena just mentioned, if the number of lobules consolidated by inflammation be considerably more numerous on one side than on the other, relative dulness on percussion may be apparent. But the same result will follow collapse of a greater number of lobules on one side from bronchial obstruction. The sub-crepitant rale belongs to both affections, but in lobular pneumonitis it is limited in its seat to the minute tubes in immediate relation to the inflamed lobules, while in general capillary bronchitis the physical conditions for the production of the sound exist everywhere throughout the lungs. In the latter affection, therefore, the sub-crepitant rale is diffused over the whole surface of the chest; and in the former it is limited to certain portions. This is the most distinctive evidence to be obtained by physical exploration, provided the positive signs of pneumonitis are not to be discovered. In the instances in which the signs are appreciable, the diagnosis is, of course, established.

With due attention to the foregoing points of distinction, cases will occur in which the discrimination is difficult, if not impossible. And it may be remarked that the uncertainty which must attach to the differential diagnosis in certain instances, accords with the present unsettled pathological views respecting the connection between bronchitis and morbid conditions heretofore considered to be dependent on inflammation of the pulmonary lobules. Recent researches tend to show that in a large proportion of the cases of the so-called broncho-pneumonia, the disease is exclusively bronchial inflammation, leading to collapse of the lobules to a greater or less extent.

Finally, capillary bronchitis presents symptoms and signs belonging alike to the form of bronchial inflammation called plastic or pseudo-membranous, which will presently be noticed under a distinct head. Remarks on the diagnostic points distinguishing these affections from each other, will be more appropriate in connection with the latter.

SUMMARY OF THE PHYSICAL SIGNS BELONGING TO ACUTE CAPILLARY BRONCHITIS.

Percussion-resonance on both sides not diminished, but often exaggerated; sonorous and sibilant rales diffused over the chest, the latter more prominent and abundant than in ordinary bronchitis; the sub-crepitant rale on both sides, and observed especially at the inferior posterior portion of the chest; coarse and fine mucous rales intermingled to a greater or less extent.

Pseudo-membranous or Plastic Bronchitis.

This variety of bronchitis is characterized by the exudation of fibrin on the mucous surface of the smaller bronchial tubes, forming what is termed false membrane, identical with the deposit which takes place within the larynx and trachea in croup. The false membrane, in cases of croup, sometimes extends downward into the bronchial subdivisions. These cases are not embraced under the present head. The deposit in plastic or pseudo-membranous bronchitis commences in the minute branches, and extends upward towards the trachea. A fibrinous exudation in some of the tubes is occasionally observed as a contingent anatomical element of capillary bronchitis; but it is the basis of a distinct form of bronchial inflammation, when it [illegible] the most distinctive and important feature of the disease. [illegible]logically, it denotes a peculiar modification, without necessarily [illegible] intensity of the inflammatory process.

The expectoration of croupal matter is preceded by cough [illegible] or less violent, generally accompanied by dyspnœa. These [illegible]istic sputa are expectorated at intervals varying greatly in [illegible] cases; days, weeks, months, and sometimes even years [illegible] Aside from this peculiar feature, the symptoms may be those [illegible] acute or sub-acute bronchial inflammation. Dyspnœa and [illegible]dences of defective hæmatosis may be absent, or present in a [illegible] proportionate to the amount of obstruction, and the number [illegible] bronchial ramifications affected. The danger and the rapid [illegible] of the disease depend on the circumstances just mentioned. [illegible]pectoration of false membrane may be followed by relief [illegible] complete. Collapse of pulmonary lobules, or solidification [illegible] extension of the inflammation to the air-cells, will add to the [illegible] of the symptoms, and the danger. Cases in which the [illegible] takes place extensively throughout the lungs, present all the [illegible]ing and alarming symptoms incident to severe capillary [illegible] and under these circumstances the disease may prove rapidly [illegible] In other instances, a small number only of the bronchial ramifica[illegible] being affected, the symptoms are comparatively mild, and not [illegible]tive of immediate danger. Under the latter circumstances [illegible] affection may continue indefinitely, or recur from time to time [illegible] after the expectoration of the membranous products, terminate [illegible] complete recovery.

This form of bronchitis is exceedingly rare. It occurs in [illegible] oftener than in females. It is not limited to any period of life [illegible] it is most frequent between the ages of twenty and fifty. Pers[illegible] debilitated, or who have previously had some pulmonary affection [illegible] more liable to the disease than those in robust health. Hæmop[illegible] is an event not belonging to this more than to other forms of bron[illegible]chitis, irrespective of the bloody points or streaks which the sp[illegible] occasionally present.

The affection may be acute or chronic. It may be partial, affecting a certain number of the bronchial tubes only; or gen[illegible] extending over the greater portion of the tubes. It obeys the la[illegible] symmetry, like the other varieties of bronchitis, when it is idiopathic. If the exudation take place extensively, or if it occur in connecti[illegible] with other pulmonary affections, a fatal result may be expected. Of the cases, however, in which false membrane, in more or less abundance is expectorated, a large proportion end in recovery.[1]

Physical Signs and Diagnosis.—The physical signs in plastic or pseudo-membranous bronchitis do not differ materially from those incident to the varieties of the disease previously considered. Exclusive of certain incidental morbid conditions, viz., collapse, solidification from inflammation, and great accumulation of liquid products within the air-tubes, percussion elicits a resonance clear and equal on the two sides. The sonorous and sibilant rales will be likely to be heard, on auscultation, more or less diffused over both sides of the chest. The moist or bubbling rales are developed in the progress of the disease, as in the other forms of bronchitis. Suppression of the rales and of all respiratory sound over portions of the chest, is liable to occur from obstruction of the tubes by the exudation, in which case it may be temporary, and variable in situation and extent; or from collapse and solidification, in the latter case being more persisting both in seat and duration. The sub-crepitant rale may be discovered, but limited to certain portions of the chest. A diagnostic point pertains to the fact last stated. The presence of the sub-crepitant rale distinguishes this from ordinary bronchitis. The limited extent of surface over which the rale is heard, distinguishes the affection from capillary bronchitis. In the latter variety, the sub-crepitant rale is diffused over the chest. It is proper to add, however, that the point of distinction just stated is determined inferentially, rather than by induction from a sufficient number of clinical observations. M. Barth and M. Cazeaux, separately, have reported each a single case in which a peculiar valvular or flapping sound (*petit bruit de soupape*), was heard on auscultation, attributed to the vibration of partially detached portions of membranous exudation. It is doubtful whether the sound be sufficiently distinctive to represent the presence of this peculiar product within the tubes. Were it a diagnostic sign, the fact of its being only occasionally observed, would render it practically of little value.

The diagnosis of plastic or pseudo-membranous bronchitis, as distinguished from other varieties of inflammation of the bronchial mucous membrane, must be based almost exclusively on the characbranous expectoration. Prior to the membranous exp symptoms and signs are not sufficiently distinctive to de decide that this particular form of bronchitis exist. If on fragments are discovered in the matter of expector appearance may at once denote their source and char quality of the inflammation, as well as its peculiar Solid or cylindrical casts not only show their bronchial indicate the seat and, in some measure, the extent of the spread. But if the false membrane expectorated consis fragmentary pieces or shreds, the fact of the exudation be ated is denoted by the quality of the voice remaining unaffe the absence of other evidences of laryngeal disease. The features just mentioned suffice for the differential diagnos croup and plastic or pseudo-membranous bronchitis.

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[1] For the results of an analysis of forty-eight cases, collected from various sources, by Dr. Peacock, vide London Med. Times, Dec. 1854, and American Jour. of Med. Sciences, April, 1855.

The period of life at which this affection is most apt to o some importance in a diagnostic point of view. In this differs from capillary bronchitis, as well as croup. The la essentially infantile diseases, while the affection under consi almost observed in persons between the ages of twenty a The age of the patient is entitled to a certain amount of we forming a probable opinion of the character of the diseas is settled by the characteristic expectoration.

It should be added, that the occurrence of the charact pectoration is not invariable. The disease may run on rap fatal termination, before sufficient time has elapsed for the p upon which the exfoliation of the croupal exudation depend completed.

The discrimination of this form of bronchitis from affectio than bronchitis, which compromise respiration and the func hæmatosis, and therefore have certain symptoms in common, in the same diagnostic points already noticed in treating of acu and capillary bronchitis, and it would be superfluous to rep them in this connection.

SUMMARY OF THE PHYSICAL SIGNS BELONGING TO PLASTIC OR PS MEMBRANOUS BRONCHITIS.

In addition to the physical phenomena, positive and negative dent to other varieties of bronchitis, a peculiar valvular or fl sound (*bruit de soupape*) has been observed. The sub-crepitan if present, less diffused than in most cases of capillary bronchi

CHRONIC BRONCHITIS.

Bronchitis, existing primarily as an acute affection, may be prolonged and assume the chronic form, but occasionally the inflammation is subacute from the commencement. Contrasted with the acute variety of the disease, chronic bronchitis offers some important points of difference, not only in its symptoms, effects, and pathological relations, but as regards the affections from which, clinically, it is to be distinguished. It therefore merits separate consideration.

Physical Signs.—So long as chronic bronchitis remains uncomplicated with any other pulmonary affection, or with lesions affecting the size of the tubes or cells, which are apt to supervene, the chest yields a clear vesicular resonance on percussion. The only exception to this rule is, occasionally the occurrence of slight or moderate dulness from excessive accumulation of the liquid products of the inflammation within the bronchial tubes. Exclusive of this exception, marked disparity between the two sides as respects resonance, assuming the chest to be well formed and symmetrical, denotes that the bronchitis is complicated with some affection which either increases the density of the lung, such as collapse, pneumonitis, tuberculosis; or, on the other hand, abnormal rarefaction from emphysema. Complications exist in chronic, oftener than in acute bronchitis; and hence, clearness and equality of the percussion-resonance are found in connection with the symptoms of the former, less commonly than in the latter affection.

The bronchial rales, moist and dry, are heard in different cases with every diversity as respects character, intensity, combination, and relative predominance of the different varieties. The bubbling rales will be abundant and diffused in proportion to the quantity of liquid within the tubes, its thinness admitting the passage of air, and the extent of its distribution. The sound will be loud and coarse when produced in the larger tubes; finer and less intense in the smaller branches. These rales will predominate in cases characterized by copious expectoration. The vibrating rales will be especially prominent in cases in which the matter of expectoration is small in quantity and viscid, adhering tenaciously to the walls of the tubes, and not readily traversed by air. In cases characterized by the formation of small solid mucous pellets (dry catarrh), a clicking, valvular sound, was described by Laennec as occasionally present, and attributed by him to their movement within the tubes to and fro by the current of air. As the inflammation is generally limited to the larger tubes, the sonorous are oftener heard than the sibilant rales; and, as in the majority of cases the expectoration is more or less copious, the mucous are more common in chronic bronchitis than the dry rales. Both the dry and moist rales may be commingled in various proportions; and the different varieties of each species may be heard simultaneously at different points on the chest. The numerous diversities which these rales may present are not only illustrated in a series of cases, but sometimes at different periods in the progress of the same case. On the other hand, in a certain proportion of cases of chronic bronchitis, the bronchial rales, so far from being prominent, are nearly wanting. They are only present occasionally, and repeated explorations may fail to discover any of them. These are cases in which the quantity of liquid products is small, and their removal by expectoration speedily effected. Sometimes in cases of this description rales may be discovered, if pains are taken to auscultate early in the morning, before the matter which may have accumulated during sleep is removed; when afterward, during the day, the tubes being kept clear by repeated acts of coughing, the chest is free from adventitious sounds. The presence or absence of the rales, and in a great measure their diversities, thus depend on contingent circumstances, which are irrespective of the severity of the disease. While the presence of the rales, in connection with the symptoms, is evidence of the existence of bronchitis, the converse does not hold true; that is, bronchitis may exist without any of the rales being discoverable. The rales may be suspended temporarily in a portion of the chest by obstruction of one or more of the bronchial subdivisions, and suddenly reproduced after an act of coughing, by which the obstruction is removed.

The vesicular murmur, when not obscured or drowned by the rales, is variable as respects intensity, but generally more or less diminished, and in some instances scarcely, if at all, appreciable. Occasionally a respiratory sound is heard resembling an exaggerated vesicular murmur, but harsher as well as louder than the normal respiration. This modification is not peculiar to chronic bronchitis, but has already been noticed in connection with the acute form of the disease. As remarked by Walshe, it is probably not of vesicular but of bronchial origin. It is, in fact, an approximation to a rale. Laennec probably had reference to this modification, in stating that in some cases of chronic bronchitis the vesicular murmur becomes puerile,—a statement not confirmed by subsequent observations. And it is probably this modification which Dr. Bowditch terms a *mucous respiration*.[1] A rational explanation is, that the swelling of the mucous membrane, or the presence of a little mucus, occasions an audible bronchial sound, but does not furnish the physical conditions for a fully developed dry or moist rale.

The vocal resonance and fremitus in chronic bronchitis, as the rule, remain unaffected. The exceptions to this rule are certainly extremely infrequent. Exclusive of the vibration perceptible to the touch which sometimes accompanies loud rales, it may be doubted if exceptions ever occur, provided the bronchitis be uncomplicated. The relatively greater degree of resonance and fremitus on the right side in health, which in some persons is marked, may have given rise to apparent exceptions to this rule.

Diagnosis.—The diagnosis of chronic bronchitis, so far as concerns the determination of the fact of its existence, is attended practically with little or no difficulty. The points which call for attentive and skilful investigation, relate to the presence or absence of complications and resulting lesions. Is the bronchitis uncomplicated? or is it associated with dilated bronchiæ, emphysema, pneumonitis, chronic pleuritis, or tuberculosis? These questions are not answered so easily as the simple inquiry whether chronic bronchitis be or be not present. In general terms, the coexistence of other morbid conditions than those pertaining to the mucous membrane is to be determined by the presence or absence of the signs and symptoms which belong to them respectively. The signs and symptoms distinctive of other affections will, of course, be embraced in the consideration of these affections individually, hereafter, and it would involve a needless repetition to introduce them in this connection. Of the several affections mentioned, the question of the coexistence of tuberculosis with the symptoms of chronic bronchitis is oftenest presented in practice; and there are few problems in diagnosis more important than the discrimination of the latter uncombined, from its combination with the former. Is this simply a case of chronic bronchitis, or is there superadded a deposit of tubercle? is a question not unfrequently arising in medical practice, which is of momentous import to the patient, and which, for many reasons, it is extremely desirable for the practitioner to be able to answer definitively. Prior to the introduction of physical exploration, this question often presented

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[1] The Young Stethoscopist, page 38, second edition.

[illegible] Cases of chronic bronchitis were [illegible] cases of phthisis, and vice versa; and it was impossible to [illegible] error. They are not necessarily hopeless to the [illegible] who [illegible] physical diagnosis. In view of the importance [illegible] the points which it involves [illegible] subject will not be fully considered [illegible] which will more appropriately come under [illegible] the diagnosis of tuberculosis. The discrimination is [illegible] mainly on the presence or absence of more or less of the [illegible] indications of tubercles; but there are certain considerations pertaining to the [illegible] signs, and laws of chronic bronchitis, which [illegible] a bearing on the question, and in cases in which the positive signs of tubercle are doubtful, are entitled to considerable weight in diagnosis. To these considerations attention will be at present [illegible]

Chronic bronchitis occurring at the period of life when [illegible] it generally takes place, succeeds, in the majority [illegible] the acute form of the disease. Tuberculosis is ushered in by bronchitis in but a small proportion of cases. Hence, in a [illegible] case, if acute bronchitis have existed at the commencement, the chances are in favor of its not being phthisis. Pain is generally absent in chronic bronchitis, and, if present, is slight, dull and [illegible] sternal. Acute stitch pains are very common in the early phthisis, due to the circumscribed pleuritis which almost invariably accompanies tubercle; and they are referred to the summit of the chest on one side, or frequently to beneath the scapula. The respirations are habitually more or less accelerated in phthisis. This obtains rarely in chronic bronchitis, and if it occur is generally paroxysmal. The pulse is often notably accelerated in phthisis, not in chronic bronchitis. Febrile paroxysms, occurring generally in the progress of tuberculosis, do not belong to the history of chronic bronchitis. Hæmoptysis is an event of very frequent occurrence in phthisis, and, excepting the occasional bloody streaks which the sputa present, it is never incident to mere bronchitis. The characteristic sputa of tuberculosis, viz., solid, nummular masses, striated, pus-colored, with ragged edges, are not observed in bronchitis. The microscope reveals in the sputa of phthisical patients, frequently fibres exfoliated from the pulmonary structure. These do not enter into the composition of the sputa furnished by the bronchial mucous membrane. The loss of weight in phthisis is generally considerable and progressive. It is less marked in chronic bronchitis.

The bronchial rales are incident to phthisis, as well as to chronic bronchitis; but in the latter affection they are most apt to be heard, or are more abundant, at the inferior and posterior part of the chest on both sides. In the former affection they are heard at the superior part of the chest in front, and frequently either limited to, or more pronounced, on one side. The preceding points are quite distinctive; but, in addition, in tuberculosis there are present more or less of the positive signs of that disease, rendering the evidence complete. These will be enumerated hereafter in treating of the diagnosis of tuberculous disease.

SUMMARY OF THE PHYSICAL SIGNS BELONGING TO CHRONIC BRONCHITIS.

Clearness of the resonance on percussion. The dry and moist bronchial rales, variously intermingled, frequently but not invariably present, heard especially over the base of the lungs on both sides. A harsh respiratory sound occasionally present. The vesicular murmur and rales sometimes temporarily suppressed, and reproduced suddenly by an act of coughing, as in cases of acute bronchitis.

Secondary Bronchitis.

Bronchitis, either acute or subacute, occurs as an intrinsic element in certain fevers, viz., typhus and typhoid, especially the latter, and rubeola. It may occur as a contingent element in other varieties of essential fevers. It becomes developed under circumstances which lead the pathologist to consider it one of the forms of the local expression of certain constitutional affections other than fever. It is regarded in this light when it coexists with gout, rheumatism, syphilis, scrofula, Bright's disease, etc. In all these instances the bronchitis is secondary to some general disease. It is liable, also, to be produced as a complication of different pulmonary diseases. Thus it is apt to accompany tuberculosis and pneumonitis, in these diseases differing from the idiopathic form in being frequently limited to one side, and even more circumscribed; in other words, not preserving its symmetrical character. In the instances last cited, it is secondary to local affections. In this category may be included the frequent instances in which it occurs in connection with pertussis. In diseases of the heart it is often developed as a secondary affection. Questions relating to the origin of the affection when thus secondarily produced, and other points of pathological interest, do not fall within the scope of this work. Considered in a diagnostic point of view, the varieties of secondary, as distinguished from idiopathic bronchitis, present peculiarities which are important. Some of these have been already incidentally noticed. Others will be conveniently referred to in treating of the diseases which remain to be considered. It does not, therefore, seem advisable to bestow upon the diagnosis of bronchitis occurring secondarily special consideration, under a separate head.

BRONCHIAL OR PULMONARY CATARRH.

The term catarrh, originally applied to affections characterized by copious liquid secretion or flux, subsequently came to be used in an extended sense to embrace most of the inflammatory affections seated in the air-passages. Inflammation of the bronchial mucous membrane is more appropriately designated by the title *bronchitis,* but the term *catarrh,* may be conveniently retained to denote either a morbid state falling short of inflammation, or an extremely mild grade of inflammatory action. In this sense pulmonary or bronchial catarrh is illustrated by the disorder popularly known as a *common cold.*

The pathological appearances, determined mainly by inference from those presented in analogous structures, accessible to view during life, are due simply to hyperæmia, consisting of redness and swelling. The mucous secretion is more or less increased and modified. Serous exhalation occurs, constituting, when abundant, a variety of bronchorrhea. As thus defined, pulmonary or bronchial catarrh is a frequent sporadic and also an epidemic affection. In a certain proportion of the cases of influenza the local morbid condition of the air-passages is of this description, a condition allied to, and often eventuating in inflammation. The affection of the bronchial mucous membrane induced secondarily in the course of fevers, the typhus and typhoid fevers especially, in many, if not most instances, falls more properly under the denomination of catarrh than bronchitis.

Cases of pulmonary or bronchial catarrh may present auscultatory phenomena identical with those observed in ordinary bronchitis; the contracted calibre of the tubes at certain points, and the presence of serum or mucus, constituting the physical conditions requisite for the dry and bubbling rales. The discrimination between bronchitis and catarrh, is to be based on the local and general symptoms which denote in the one case the existence, and in the other case the non-existence of inflammation; and inasmuch as the latter merges into the former so insensibly that it is not easy to define the exact line of demarcation dividing them, it is not always practicable to make the distinction clinically. The point, however, is not one of great practical consequence.

Limiting the attention to the diagnosis, exclusive of questions relating to etiology, pathological relations, &c., these few words comprise all that need be said under the head of pulmonary or bronchial catarrh.

CHAPTER II.

DILATATION AND CONTRACTION OF THE BRONCHIAL
PERTUSSIS—ASTHMA.

THE affections named in the caption of this chapter, are tho
in addition to bronchitis and pulmonary catarrh, have their
special manifestations in the bronchial tubes. The two fir
dilatation and contraction, are lesions affecting the calibre
tubes. Pertussis or hooping-cough is an infantile disorder, th
mary and prominent local symptoms of which pertain to the
nary air-passages. Asthma is characterized by phenomena
appear to be dependent on spasm of the bronchial muscles.

DILATATION OF THE BRONCHIAL TUBES.[1]

Dilatation of the bronchiæ was scarcely known to path
prior to the researches of Laennec. The inference naturally
from this fact relative to the rare occurrence of the lesion is
gether correct. The inattention paid to the condition of the br
tubes in autopsical examinations led to the existence of
tion being often overlooked, and sometimes confounded with
culous excavations. The same remark will apply in a great
to examinations since the time of Laennec; so that at the
moment it is not easy to determine very accurately the degr
its frequency. Grisolle estimates that in a very active hospital
vice an average of one or two cases will be likely to be me
annually. Generally, if not uniformly associated with bronchi
probably, in most instances, involves the latter affection in its pr
tion. The mode in which it is produced is an interesting poi
pathological inquiry, admitting of extended discussion. But it w
be a digression from the range of practical topics to which this

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[1] Called *Bronchiectasis*. This name is too formidable for common use, and I
therefore adopt it.

is limited, to indulge in more than a brief passing allusion to it. Laennec attributed the dilatation chiefly to mechanical distension of the bronchial parietes from the accumulation of mucus. This explanation is now generally deemed inadequate, and the accumulation is regarded as rather the effect than the cause of the dilatation. A morbid condition of the walls of the tubes, impairing their elasticity, and rendering them less resisting to dilating forces, is, probably, as first pointed out by Dr. Stokes, a pre-requisite, the result usually of prolonged inflammation. Hence, the lesion is one of the sequels of chronic bronchitis. With regard to the causes more immediately engaged, they are doubtless not in all cases the same. Extraordinary efforts of the respiratory organs, as in the violent paroxysms of coughing which occur in pertussis, may prove the efficient cause in some instances. Obstruction of a bronchus by the pressure of an enlarged bronchial gland, or other causes preventing the exit of air and mucus, may occasion sufficient distension behind the obstruction to lead to permanent enlargement. But in the great majority of cases, there is reason to believe the dilatation depends on a prior morbid condition of the pulmonary parenchyma. Dr. Corrigan[1] has described a special affection involving this lesion, consisting in a morbid deposit around the tubes, which assumes the characters of fibro-cellular texture, leading to atrophy and obliteration of the pulmonary cells, and, in some instances, even contraction of the entire lung. Under these circumstances, according to his views, two active forces are combined in producing bronchial dilatation. One is the pressure of the atmosphere from within the tubes in an outward direction, to fill the vacuum caused by the diminution of the bulk of the surrounding parenchyma. The other is the traction exerted on the bronchial walls in consequence of the adventitious fibro-cellular deposit becoming attached to the longitudinal fibres of the tubes, so that dilatation in this way results from the shrinking of the surrounding tissue. The morbid condition supposed to induce the lesion in the manner just mentioned, Dr. Corrigan calls *cirrhosis* of the lung, from an apparent resemblance to the affection of the liver known by that title. The contraction of portions of lung incident to the tuberculous deposit, and still more to the cicatrization of cavities, may induce dilatation of the bronchial tubes, the walls expanding to compensate for the vacant space. More frequently, however, this result follows obliteration of more or less of the pulmonary cells from pneumonitis, and the compression to which they are subject in cases of pleurisy. When the parietes of the chest do not readily collapse to fill the space left by the absorption of the intra-vesicular deposit in pneumonitis, and the liquid effusion in pleuritis, the bronchial tubes, previously weakened by the process of inflammation, yield to the pressure of the inspired air. Under these circumstances what will be presently noticed as the uniform or cylindrical variety of dilatation occurs, affecting in some instances the tubes of an entire lobe or lung. Finally, according to Hope and Rokitansky, collapse of portions of the lung from obstruction of the lesser bronchial twigs in some cases of bronchitis, when the collapsed portions are situated at considerable depth in the lung, and near a larger bronchial tube, may give rise to dilatation, on the principle which plays the most important part in the production of the lesion in connection with most of the affections to which it is consecutive, viz., expansion from the pressure of the inspired air to fill a vacuum.[1]

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[1] Dublin Medical Journal, May, 1838.

With reference to the practice of physical exploration, dilatation of the bronchial tubes is a lesion of interest and importance, from its giving rise to signs which are liable to lead to errors of diagnosis.

Following Laennec, subsequent writers have described three varieties of dilatation. One variety consists in a spherical, sacculated, or pouch-like dilatation, occurring usually in the third or fourth subdivisions, forming, in effect, a cavity which may attain the size of a walnut, and according to Rokitansky, a hen's egg. A second variety, which is essentially similar, consists in a series of globular dilatations along the course of a tube, the calibre of the intermediate portions retaining the normal size. The tube presents an appearance compared by Elliotson to a string of beads. In the third variety, a cylindrical and nearly uniform enlargement of a tube, with more or less of its branches, takes place. The last species of dilatation sometimes extends over a whole series of bronchial subdivisions, the enlargement gradually increasing toward their extremities, ending abruptly in cul-de-sacs; the appearance when laid open being not unlike that of the finger of a glove. Occasionally the several forms of dilatation are combined in the same lung.

Bronchial dilatation associated with obliteration of the cells, and contraction of the pulmonary parenchyma, is attended with a corresponding amount of diminution of the size of the chest, sometimes with displacement of the movable viscera. In all such instances, probably, the diminished bulk of the lung and consequent collapse of the thoracic parietes precede the dilatation.

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[1] The reader desirous of a fuller exposition of the mechanism of the production of this lesion may consult with advantage the works on Pathological Anatomy by Hasse, Am. Ed. page 280, et seq.; Jones and Sievekings, Am. Ed. page 389; and Rokitansky, Syd. Ed. vol. iv, page 5.

The surrounding pulmonary parenchyma is more or less condensed. This is necessarily, to some extent, a result of the pressure of the expanded portion of the tube; but according to Corrigan, in a certain proportion of cases it is increased by the exudation of a solid material which preceded the dilatation. The dilated tubes contain puriform liquid in greater or less quantity.

Cases have been observed in which several globular dilatations existed near the apex of the lung, communicating by intervening bronchiæ, so as to resemble closely a united group of excavations similar to those not unfrequently met with in subjects dead with tuberculous disease. Under these circumstances the lesion, on a superficial examination, might readily be considered to have proceeded from phthisis. In the other forms, bronchial dilatation was formerly, as already remarked,[1] confounded with phthisical cavities. On the other hand, in the opinion of a distinguished pathologist, many of the instances of the so-called cirrhosis of the lung are, in fact, cases of tuberculous cavities.[2]

The anatomical conditions sustaining proximate relations to the physical signs in cases of dilatation, are the degree and extent of the enlargement, and the particular form which it assumes; the size of the bronchial tubes connected directly with the dilated portion, or portions; the presence or absence of mucus, and its abundance when present; the diminished bulk of the lung, partially or entire, and the consequent contraction of the thoracic walls.

Physical Signs.—Dulness on percussion generally attends dilatation of the bronchial tubes. The dulness is due mainly to the condensation and contraction of the parenchyma which accompany the dilatation, and it is marked and diffused in proportion to the degree and extent of the abnormal density which the lung acquires. The dulness may be somewhat increased at times by an accumulation of mucus within the enlarged tubes. To the foregoing rule there are exceptions. Increased clearness of percussion-resonance is occasionally observed, notwithstanding the pulmonary parenchyma surrounding the enlarged tubes is more or less condensed and contracted. This arises from the air within the tubes being sufficient to overbalance the abnormal density of the lung. The resonance under these circumstances becomes either purely tympanitic (tubular), or vesiculo-tympanitic. The vesicular quality, in other words, is impaired or lost, and the pitch raised. The resonance may even assume an amphoric character. Increased clearness is of course only present when the bronchial tubes are free from morbid products; and as their condition in this respect varies at different times, percussion will elicit only at certain periods, a clear sound which will be found to alternate with dulness, the latter being present when the tubes are more or less filled with mucus.

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[1] The test of cavities formed by bronchial dilatation, in doubtful cases, is the presence of the characters of the mucous membrane in the tissue lining the cavities, as determined by microscopical examination.

[2] Prof. J. Hughes Bennett. I take the liberty of making this statement on the strength of a verbal expression of the opinion to the writer. See also, Treatise on the Pathology and Treatment of Pulmonary Tuberculosis. Edinburgh edition, pages 48 and 49.

The physical conditions are more eminently favorable for the production of tubular or bronchial respiration, when the tubes are unobstructed, provided the dilatation be of the cylindrical variety. The enlarged calibre of the bronchiæ and the pulmonary condensation combine to render the respiratory sound non-vesicular and blowing. The bronchial characters are strongly marked and the sound intense, *ceteris paribus*, in proportion to the enlargement and increased density. The diffusion of the tubular respiration will correspond with the space over which the dilatation extends.

The presence of mucus within the dilated tubes in greater or less abundance gives rise to moist bronchial or bubbling râles, occurring at irregular periods, and variable in loudness, as in simple bronchitis. A degree of coarseness approaching to gurgling will be likely to characterize these mucous rales if the calibre of the tubes be considerably enlarged.

The vocal resonance is generally exaggerated, and bronchophony is often strongly marked. Vocal fremitus is increased sometimes in a notable degree. An abnormal transmission of the heart-sounds may also be observed.

The affection in some instances leads to changes apparent on inspection. The condensation and contraction of the pulmonary parenchyma may be sufficient to cause depression of the chest over the site of the lesion, rarely, however, so great as obtains in some cases of advanced tuberculous disease. In the form of the disease described by Corrigan, the diminished bulk of the lung leads to an obvious contraction of one side of the chest.

In the sacculated or cystic variety of dilatation, provided the enlargement be considerable, there may be present the physical signs of a cavity, viz., the cavernous respiration, gurgling, and in some instances pectoriloquy. Even metallic tinkling was observed in a case reported by Dr. Barlow, of London.[1]

Diagnosis.—The diagnosis of dilatation of the bronchial tubes is frequently attended with extreme, and in some instances insurmountable difficulty, owing to the physical signs being similar and indeed identical with those incident to other forms of disease. The liability to error arising from the fact just stated, renders it important to bear in mind the diagnostic points by which this lesion is to be discriminated from affections involving analogous physical conditions, but differing widely in pathological features.

Bronchial respiration, increased vocal resonance, bronchophony, and exaggerated fremitus, are signs which accompany the consolidation of lung incident to pneumonitis, and tuberculosis. With acute pneumonitis, dilatation of the tubes can hardly be confounded, except the attention be directed exclusively to the physical signs. The one is an acute, and the other eminently a chronic affection. As respects acute symptoms, a resemblance exists only when acute bronchitis supervenes on bronchial dilatation. Under these circumstances the pulmonary symptoms will be those belonging to bronchitis, exclusive of the distinctive features of pneumonitis, viz., lancinating pains and the rusty or bloody expectoration. The characteristic auscultatory sign of pneumonitis, viz., the crepitant rale, is absent. Were the mistake to occur of attributing the combined phenomena of bronchial dilatation and acute bronchitis, to pneumonitis (which with due care should not be made), the progress of the disease would in a short time lead to a correction of the error, for the physical signs which were incorrectly supposed to denote inflammatory solidification are found to remain, and perhaps become more marked after the local and general symptoms of acute inflammation have disappeared. In pneumonitis, on the contrary, these signs cease to be observed, or at least are notably lessened, shortly after the symptoms denote resolution of the inflammation. From chronic pneumonitis the discrimination must be less easy. But chronic pneumonitis is an affection so rare that, practically, the fact of its occasional occurrence may almost be disregarded. When it occurs, it is generally preceded by the acute form of the disease. If in a doubtful case the pre-existence of acute pneumonitis be clearly determined, this constitutes an important diagnostic point. Moreover, chronic pneumonitis is accompanied by general symptoms indicative of a graver malady than simply bronchial dilatation. The situation of the pulmonary affection, as indicated by the physical signs, is a point of importance. Pneumonitis in the great majority of cases attacks the inferior lobe; bronchial dilatation in most instances is seated in the upper lobe.

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[1] Guy's Hospital Reports, 1847.

The difficulty of diagnosis relates chiefly to the discrimination of bronchial dilatation from tuberculous disease. Each of the two forms of dilatation, viz., the sacculated and cylindrical, furnishes signs which belong equally to different stages of phthisis. Bronchial respiration, bronchophony, increased vocal fremitus, which attend cylindrical dilatation, denote, under certain circumstances, the presence of crude tubercle. Cavernous respiration and gurgling are the signs of an excavation in forty-nine of fifty cases tuberculous in its origin. The discrimination is to be based, not on intrinsic differences in the physical phenomena, but on circumstances incidental thereto, and on the symptoms. Reasoning from negative facts, we may arrive at the conclusion that the phenomena are due to bronchial dilatation, because the absence of coexisting evidence of tuberculous disease renders it probable that the latter disease may be excluded.

The differential diagnosis involves different points, whether the dilatation be cylindrical or sacculated, but the physical signs being different in the two varieties, they claim separate consideration.

Dilatation of the cylindrical variety may present, as just stated, a group of physical signs which, in connection with cough and expectoration, may appear to indicate a tuberculous deposit. What are the circumstances favoring the conclusion that these signs and symptoms are due, not to tuberculous disease, but to dilatation of the tubes? The situation of the physical signs, viz., the bronchial respiration and bronchophony, is an important point. A deposit of tubercle takes place, in the vast majority of cases, first at, or near the apex of the lung. The physical signs of tuberculous consolidation are therefore found at the summit of the chest, especially marked in the clavicular, supra-clavicular, and infra-clavicular regions. The phenomena due to bronchial dilatation, on the other hand, are oftener manifested over the middle portion of the chest, than at the summit. Taken in connection with other circumstances, this is a strong diagnostic point; but it is to be borne in mind, that the rule with respect to the situation of the tuberculous deposit is not without exceptions, so that this point, by itself, is by no means sufficient for the diagnosis.

More or less dulness on percussion, as has been seen, attends dilatation, dependent on the degree and extent of the coexisting condensation. The bronchial respiration and bronchophony are due, in part, to the greater density of the pulmonary tissue, but more to the enlarged calibre of the tubes. In tuberculous disease, these phenomena proceed exclusively from the consolidation; and, other things being equal, they are intense in proportion to the increased density of lung. Hence, in tuberculous disease, bronchial respiration and bronchophony are not observed in a notable degree without physical evidence of a considerable amount of consolidation being at the same time afforded by percussion. In dilatation, on the contrary, the enlargement of the calibre of the bronchial tubes may be considerable, and the condensation moderate or slight. Under these circumstances, the bronchial respiration and bronchophony may be strongly marked, while the percussion-resonance is but little impaired. A striking disproportion, then, between these auscultatory phenomena, and the evidence furnished by percussion of pulmonary solidification, authorizes, to say the least, a presumption in favor of dilatation.

The point to which most importance is to be attached is the absence of the rational evidence of phthisis derived from the history and symptoms. In cases of dilatation, cough and expectoration generally have existed for a long period. If the affection be tuberculous, certain events and results are to be expected, which, if the affection be dilatation, the case will not be likely to present. Among these events and results the most prominent are progressive and marked emaciation, loss of muscular strength, pallor of the countenance, hæmoptysis, lancinating pains in the chest, diarrhœa, marked acceleration of the pulse, hectic paroxysms, night perspiration, chronic laryngitis. If all these are absent, the fact favors the supposition of dilatation being the pathological change giving rise to physical phenomena which, associated with more or less of the symptomatic phenomena just enumerated, would denote unequivocally the existence of tuberculous disease. Occasionally, however, it happens in cases of phthisis, that nearly all these rational indications are wanting. Hence, under these circumstances it is not safe to decide positively from their absence that tuberculosis may be excluded.

From this consideration of the differential diagnosis it will be justly inferred that it is extremely difficult to determine that certain physical signs are due to cylindrical dilatation of the bronchial tubes, and not to tuberculous solidification. In fact, the discrimination can rarely be made with great positiveness. This would be a serious impediment in the way of determining the existence of phthisis, were cases of dilatation of frequent occurrence. Fortunately for diagnosis, although unfortunately for human life, the latter lesion is as rare as the former affection is common. And for this reason were the practitioner to disregard the fact that cases of dilatation are occasionally met with, and not attempt to make the discrimination in practice, the chances of a false diagnosis are small.

Dilatation of the sacculated or cystic variety, giving rise to cavernous signs, viz., cavernous respiration, circumscribed mucous rales or gurgling, and in some instances pectoriloquy, have occasionally led those most experienced and skilled in physical exploration into the error of inferring the existence of a tuberculous excavation.

The situation of the cavity is an important point, for reasons already stated.

Tuberculous excavations are generally surrounded with considerable solidification from the presence of crude tubercle. Hence the cavernous signs furnished by auscultation usually coexist with marked dulness on percussion. This is less uniformly true of cavities formed by dilatation of the bronchiæ. The presence of cavernous signs, therefore, with slight dulness surrounding the site of the cavity, favors the hypothesis of dilatation. The signs of cavities from dilatation may be unattended by any appreciable dulness on percussion. This was true of a case of bronchial dilatation, simulating phthisis, reported by Louis.[1] In the case referred to, an error of diagnosis is admitted by that conscientious and accomplished observer. In view of the law of phthisis by which the deposit almost uniformly takes place, first at, or near, the apex of the lung, if the percussion-resonance above the site of a cavity, in other words in the supra and infra-clavicular region on the same side, be found to be clear and vesicular, this, although by no means positive proof against the existence of tuberculosis, since the law just stated is not invariable, concurs with other circumstances to render the supposition of dilatation probable.

Another point pertaining to the physical signs is applicable to both varieties of dilatation, but to the present variety more particularly. The dilatation is generally, or at least frequently, limited to one lung. A tuberculous deposit takes place first in one lung, and in the great majority of cases, shortly afterward in the other lung. In cases of phthisis, therefore, advanced to the stage of excavation, there may be expected to be present on both sides of the chest physical signs of tuberculous disease. Now, if with the evidences of a cavity on one side, the other side yield no signs of disease, the fact favors the exclusion of tuberculosis.

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[1] Recherches sur la Phthisie.

If a case has been under observation for a considerable period, the existence of tuberculosis is evidenced by the physical signs of excavation becoming developed where previously the signs had denoted solidification. This succession of physical phenomena does not belong, certainly to the same extent, to the history of dilatation. And with some qualification and occasional exceptions, the general rule, laid down by Stokes on this subject, probably holds good, viz.: "In phthisis, we have first dulness, and then cavity; while in dilated tubes, we have first cavity, and then dulness."

The persistency of the cavernous signs without material alteration for weeks, months, and even years, is another point pertaining to physical exploration, which has considerable diagnostic weight. A stationary condition after the stage of excavation in phthisis is reached, is possible, and occasionally occurs, but only as a rare exception to the general rule.

A notable degree of flattening of the chest at the summit is strong evidence against dilatation, the depression thus limited in this affection never being strongly marked.

The absence of the rational evidence of phthisis derived from the history and symptoms, applies with greater force to the discrimination when the question relates to the presence of sacculated dilatation or phthisis advanced to excavation, for a longer duration of the tuberculous disease, if it exist, is implied, and therefore the events and results characteristic of the latter affection are less likely to be wanting. A cavity without notable emaciation, loss of strength, pallor, hæmoptysis, lancinating pains, recurring diarrhœa, frequency of pulse, hectic fever, night perspirations, or chronic laryngitis, but associated with more or less cough and expectoration of long duration, may be attributed to dilatation with much confidence. In this statement it is of course understood that cavities from abscess, or circumscribed gangrene, are excluded.

In connection with the subject of the differential diagnosis of dilatation and tuberculosis, the fact is not to be lost sight of, that both may exist conjointly. As remarked by Walshe: "This compound state is, probably, beyond the reach of diagnosis." Dr. Bowditch[1] gives an instance of a youth who consulted him five minutes after an attack of hæmoptysis, stating that he had been quite well up to this occurrence, save that he was liable at times to a cough, and in early life had had severe pulmonary symptoms. Expecting to find few if any physical signs of disease, Dr. B. was surprised at discovering bronchial and cavernous respiration, with bronchophony and pectoriloquy, throughout the whole of the left lung. On this side there was a contraction as if from old pleurisy. Three months afterward death occurred from tubercles developed in the other lung, and the bronchiæ enormously dilated were found to fill up the major part of the lung over which had been heard the physical signs above mentioned. The protective influence of dilatation against tubercle is illustrated in this instance, the deposit taking place in the lung free from that lesion.

A case which recently came under my observation will serve to illustrate certain of the diagnostic points involved in the differential diagnosis of dilatation and tuberculosis, and at the same time, the difficulty of discriminating with positiveness. The patient, aged 45, a blacksmith, had suffered from cough and expectoration for fifteen years. He stated that he had had several hæmorrhages from the lungs. He had, however, continued to labor at his trade till within a few weeks, and was then interrupted not by an increase of his pulmonary symptoms, but by an affection of a testicle. He was not emaciated; did not present the aspect of a tuberculous patient, and had recently gained in weight. Over the left chest the percussion-resonance was moderately dull, with a somewhat tympanitic quality. Over the upper and middle thirds, in front, of the left side, bronchial respiration was intense, the expiration notably prolonged, high in pitch, and metallic. Strong bronchophony coexisted, the voice seeming very near the ear. Whispered words were accompanied by a strong *souffle*, and transmitted to the ear with considerable distinctness (whispering pectoriloquy). The right side presented a well-evolved and perfectly normal vesicular respiration, with clear vesicular percussion-resonance.

The history, symptoms, and signs in this case certainly point to dilatation. But the occurrence of hæmoptysis renders it doubtful whether the case be not one of tuberculosis, presenting deviations from the usual course of that disease. I cite the case to show the uncertainty which must frequently attend the diagnosis.

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[1] Young Stethoscopist, second edition, page 104.

SUMMARY OF THE MORE IMPORTANT OF THE DIAGNOSTIC CHARACTERS.

The physical signs accompanying cylindrical dilatation, viz., bronchial respiration, exaggerated vocal resonance, or bronchophony, and increased vocal fremitus, found to be persistent, and, unless acute bronchitis coexist, unattended by any of the signs and symptoms of acute pneumonitis. If acute bronchitis coexist, certain of the signs and symptoms distinctive of acute pneumonitis absent, viz., lancinating pains, bloody or rusty expectoration, and the crepitant rale. The bronchial respiration and bronchophony not diminished, and perhaps increased after the symptoms of acute bronchitis have disappeared. The previous history not showing the existence of prior acute pneumonitis, which is generally true of cases of chronic pneumonitis. The bronchial respiration and bronchophony oftener found over the upper than over the lower lobe. Frequently a disproportion between the auscultatory phenomena, and the evidence of solidification afforded by percussion. The general symptoms denoting a less grave affection than chronic pneumonitis.

Contrasted with phthisis, the auscultatory phenomena, viz., bronchial respiration, bronchophony, cavernous respiration, gurgling, and pectoriloquy, rarely found at the summit of the chest. Frequently, the dulness on percussion relatively to these auscultatory phenomena, proportionately less than in most cases of tuberculosis; and in some instances no dulness existing, or the percussion-resonance clear at the summit. The physical signs when strongly marked and diffused over a considerable space, inclusive of the phenomena due to cavities, frequently limited to one side of the chest. The cavernous signs not preceded, but sometimes followed, by notable dulness on percussion. The physical phenomena persisting for a long period without any material alteration. Absence of the rational evidence of phthisis derived from the symptoms and effects of the latter affection, such as great emaciation, feebleness, anæmia, hæmoptysis, sharp pleuritic pains, tuberculous fever, hectic, night perspirations, and chronic affection of the larynx.

CONTRACTION OF THE BRONCHIAL TUBES.

Abnormal diminution of the calibre of the bronchial tubes may be produced in different modes, and occurs in various pathological connections. It varies in extent, being sometimes limited to a small space, and in other instances extending to considerable distance. Its situation may be near, or more or less remote from the primary bronchus. In degree it is variable. It may end in complete obliteration. Obliteration of the bronchial tubes, strictly considered, is a lesion distinct from contraction. For practical purposes, however, it suffices to notice both under the head of contraction. As occurring in connection with the different varieties of bronchitis, contraction and even obliteration of bronchiæ have been already referred to. Exclusive of these connections, existing as permanent lesions, they are rare, and to determine their existence during life by signs and symptoms, in the great majority of instances is probably impossible. To the diagnostician they are interesting, chiefly in the light of disturbing elements, as it were, in physical exploration, giving rise to phenomena which may simulate other affections or modify their characters, occasioning embarrassment if not error.

The attention of pathologists was first called to the occasional occurrence of permanent contraction and obliteration of the bronchial tubes by a French observer, M. Reynaud, in 1835.[1] Reynaud was led by his observations to the opinion that bronchial obliterations were not very uncommon. Hasse, however, suggests that he may not have distinguished in all instances between the simple obstruction produced by the presence of exudation of lymph in plastic bronchitis, and acute obliteration arising from organization of the exudation, or adhesion of the walls of the tubes. As described by Reynaud, and others, contraction and obliteration may be continuous, extending either over a single tube or a series, and sometimes all the tubes of a lobe, which is compared by Prof. Gross, to continuous stricture of the urethra, or the tubes may be narrowed or closed at one or more points, as if a ligature had been applied.[2]

The obstruction incident to obliteration, or a considerable degree of contraction, induces other physical changes in the pulmonary organs. Dilatation of the tubes, forming either a pouch-like cavity just before the point of the obstruction, or an enlargement, extending more or less along the tube leading to that point, is apt to follow. Beyond the contracted or obliterated tubes, the pulmonary lobules dependent thereon for their supply of air, become atrophied, shrivelled, or collapsed. And in consequence of the effect just mentioned, surrounding lobules are likely to take on an abnormal increase of bulk, becoming, in other words, emphysematous. This compound state defies diagnosis.

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[1] Mém. de l'Académie Roy. de Méd. vol. iv. 1835.

[2] These two varieties are described and figured in Gross's Pathological Anatomy, to which the reader is referred.

It is obvious, that the extent of the consecutive pulmonary changes, together with the symptoms and signs, will depend on the size of the bronchial tube, or tubes, which are contracted or obliterated, as well as on the amount of obstruction, provided complete occlusion does not exist. Continuous obliteration affects usually the smaller divisions of the bronchiæ. Contraction or obliteration limited to a small portion of the tube, is observed principally in bronchiæ of the second or third order.[1] Obstruction more or less complete, however, has been met with at different situations between the bronchi and the minute ramifications. Seated in a primary division of the bronchi, or, if the contraction or obliteration be continuous, extending over all the tubes of an entire lobe, the functions of the lobe will, of course, be interrupted or suspended, according as the supply of air is more or less diminished or cut off. The atrophy and collapse of the lobe which ensue are proportionate to the obstruction. These results will be less extensive, of course, in proportion as the obstruction is limited to the smaller tubes.

The immediate local causes of diminished calibre of the tubes, and obliteration, are either situated within or exterior to the bronchiæ. Within the tubes, they consist of plastic exudation upon the mucous surface; a tuberculous deposit, occurring at the same time within the vesicles; hypertrophy of the mucous membrane; morbid excrescences springing therefrom; contraction from cicatrized ulcers; foreign substances received from without, and solid morbid products, viz., calcareous formations, melanotic cysts, or acephalocysts gaining entrance into the tube from within. In the list of causes seated in the interior of the tube are also to be included submucous deposits of serum, or lymph, carcinomatous matter, etc. The causes situated exteriorly act by producing pressure on the tube, or tubes. Among the numerous causes embraced in this class are enlarged bronchial glands; masses of tubercle; aneurismal or other tumors; and pleuritic effusions. Several cases were reported some years ago by Mr. T. W. King, of London[2], in which pressure of the left auricle, in connection with enlargement of the heart, was found to have occasioned considerable flattening of the left bronchus, reducing its calibre sufficiently to produce partial obstruction. From the foregoing enumeration, it is evident that, as already stated, the pathological relations of contraction and obliteration of the tubes are various.

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[1] Gross's Path. Anat. page 419.

[2] Guy's Hospital Reports, April, 1838. For summary, see Gross's Path. Anat., page 420.

That these lesions give rise to important symptoms and signs is certain. Embarrassment of respiration, manifested by dyspnœa, may accompany cases in which the obstruction is seated in a bronchial tube of large size, more especially when the obstruction is rapidly induced, and if it occur in connection with some other affection which compromises the pulmonary functions. Nothing, however, pertaining to the embarrassment of respiration would indicate specially these lesions. The signs, theoretically determined, are dulness on percussion in proportion to the number of pulmonary lobules shrivelled or collapsed, provided emphysematous dilatation of the surrounding cells be not sufficient to compensate for the condensation. In the latter case the clearness may be preserved, with perhaps a vesiculo-tympanitic quality. Both conditions, *i. e.* the collapse of certain lobules, and the over-distension of others, combine to render the respiratory murmur feeble or inaudible. The phenomena incident to bronchial dilatation may coexist, and supersede those due directly to the contraction or obliteration of the tubes. In like manner the signs belonging to the latter may be lost among those to which the various associated morbid conditions give rise. If the situation and degree of the obstruction be such as to occasion collapse, more or less complete, of an entire lobe, depression of the thoracic walls will follow. This, as well as the other signs, will be likely to be presented over the superior and middle thirds in front, owing to the fact that the lesions have been oftener found in the upper than in the lower pulmonary lobes.

Finally, to determine positively the existence of these lesions during life, as already stated, is not to be expected in the great majority of instances. The coexistence of feebleness or absence of respiratory sound, with dulness and perhaps depression, under circumstances when this combination of signs is not otherwise explicable, points to obstruction of a large bronchial tube, and this opinion may sometimes be formed with considerable confidence. The grounds for this opinion are less in proportion as the contraction and obliteration are limited. The same combination of signs, situated elsewhere than at the summit of the chest, warrants a suspicion of the existence of these lesions. This suspicion may be indulged the more if the patient have suffered from chronic bronchitis; and still more if plastic exudation, in the form of bronchial moulds, or if calculi, have been expectorated. Situated at the summit of the chest, these signs would be considered to denote a tuberculous deposit; and, it is not improbable, as intimated by Stokes, that in a certain proportion of the instances in which a false diagnosis of phthisis is made, the physician is misled by the phenomena due to permanent obstruction of bronchiæ. Fortunately for diagnosis, the lesions are extremely rare.

PERTUSSIS—HOOPING-COUGH.

The seat of hooping-cough is indeterminate; but its primary and prominent symptoms appear to depend on a morbid condition of the bronchial tubes. Nosologically, it may properly enough be classed among neurotic affections, and like the other neuroses it is devoid of any appreciable anatomical characters. The morbid appearances found after death do not belong intrinsically to the disease, but are due to its complications, independently of which it very rarely, if ever, proves fatal. The most frequent complications are bronchitis and pneumonitis. Others less common, are tuberculosis, croup, pleuritis, enteritis, and convulsions. I have observed abdominal tympanitis irrespective of any other apparent intestinal complication, a symptom mentioned by M. Blache, as incident to this affection.

Bronchial dilatation and pulmonary emphysema are occasional sequels of hooping-cough, the latter, according to Rilliet and Barthez, much less frequently than is generally supposed. External emphysema of the areolar tissue from rupture of the lungs, has been known to be produced by the violence of the cough.

Physical Signs and Diagnosis.—There are no physical signs characteristic of hooping-cough. During the catarrhal period, the bronchial rales incident to catarrh and mild bronchitis may be heard, and also, more or less, during the continuance of the disease. These, of course, only show the coexisting irritation or inflammation of the mucous membrane. During the paroxysms, the series of expiratory efforts exhaust the quantity of air in the pulmonary cells, sufficiently to produce an appreciable diminution of the percussion-resonance; and during the prolonged hooping inspiration, the expansion of the cells is unaccompanied by an audible vesicular murmur. The latter is probably owing to reduction in the column of air caused by the contraction at the glottis.

The diagnosis of hooping-cough is to be based on the symptoms and laws of the disease. These are so striking and distinctive that it is recognized in the great majority of cases without difficulty after the characteristic traits become developed. During the catarrhal period, the disproportionate violence of the cough in comparison with the other pulmonary symptoms, its abruptness and paroxysmal character, with more or less of the peculiarities which are afterward so prominent, furnish grounds for a probable diagnosis; but without the opportunity to observe for himself, relying upon the description given by others, the practitioner is often at a loss to form a positive opinion until the affection has passed to the spasmodic stage. At this period, in children, there is little room for hesitancy, except what sometimes happens, the symptoms are so extremely mild, that the special characteristics are not prominent. Cases of this kind are, however, extremely rare. In adults, the affection is less readily recognized from the fact that the hooping inspiration is less uniformly present. Moreover, from the infrequency of cases of the disease in adults, it may escape detection, because the possibility of its existence may not occur to the mind of the physician.

Physical exploration may furnish useful information concerning complications which are liable to become developed in the course of the disease. The presence of the dry and bubbling rales during the intermissions between the paroxysms of coughing, shows the coexistence of bronchitis, and by their character, extent, and situation, the practitioner is enabled to judge of the number and size of the tubes affected, as in cases of primary bronchial inflammation. Negatively the absence of physical signs, or the presence only of those belonging to bronchitis, are important, in determining the non-existence of other and more serious complications, viz., pneumonitis, tuberculosis, pleuritis, and emphysema. The existence of any one or more of the complications just named, is to be determined by means of the physical evidence of their presence, taken in connection with vital phenomena. But inasmuch as the diagnosis of these several affections will be considered fully hereafter, and the points involved in their discrimination when they are superadded to hooping-cough are essentially the same as when they are primary, it would involve a needless anticipation of future topics to treat of their symptoms and signs in this connection.

Asthma.

The term asthma, formerly applied to dyspnœa, occurring as a symptom of different diseases of the organs of respiration and the circulation, is now restricted to a paroxysmal affection, the primary local manifestations of which consist in spasmodic contraction of the circular muscular fibres of the smaller bronchial tubes. Like the affection last considered (hooping-cough), it belongs, nosologically, among the neuroses, and is consequently wanting in appreciable anatomical characters. Although not a very rare form of disease, it is very rarely met with in practice as a purely neurotic affection; in other words, in a large proportion of cases it is associated with morbid conditions other than spasm, to which it stands in the relation either of cause or effect. Its existence, however, independently of other affections, is sufficiently established.

Physical Signs.—The physical signs during the paroxysms of asthma are not in a positive sense distinctive. Exploration of the chest is useful chiefly in a negative point of view, enabling the practitioner to exclude other affections accompanied by dyspnœa, and also to detect complications. Percussion elicits clearness of resonance. From the very frequent coexistence of emphysema, the percussion-resonance, in the majority of cases, is clearer than in health, with, perhaps, more or less tympanitic modification. If emphysema be not present, the volume of the lungs may be reduced by the expiratory efforts so as to diminish appreciably the clearness on percussion.[1] Owing to the obstruction to the entrance of air into the cells, the lungs may not expand readily to fill the vacuum caused by the enlargement of the chest by inspiration. Hence, the pressure of the atmosphere occasions obvious retraction of the epigastrium, the thoracic walls of the lower part of the chest in front, and sometimes depression above and below the clavicles, with the inspiratory acts. The vesicular murmur is scarcely or not at all appreciable, and is replaced by sibilant and sonorous rales, commingled in varied and constantly varying proportions, the former generally predominant with inspiration. The dry rales also accompany the act of expiration; the sonorous oftener predominating during this act. The rales with inspiration frequently merge into those attending expiration, so that they appear to be continuous. They are diffused extensively over the chest on both sides, and the sounds are generally loud and diversified, whistling, chirping, cooing, snoring, etc., in alternation, or heard simultaneously in different portions of the chest. The moist or bubbling rales are rarely present during the severity of the paroxysm; but may be observed toward its close, at the time when expectoration is apt to occur. After the paroxysm, bronchial rales generally continue to be heard for several days, and finally cease, provided the patient does not labor under a persisting chronic bronchitis.

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[1] Walshe, op. cit.

Diagnosis.—The diagnosis of asthma rests on the occurrence of paroxysms of difficult respiration, presenting the physical phenomena just described, and the exclusion of other affections which may give rise to paroxysmal dyspnœa, resembling more or less that originating from spasm of the bronchial muscles.

In a child, an attack of asthma may, at first, excite suspicions of croup. But a little examination suffices to show that the obstruction is not seated at the larynx. The absence of the striking characters pertaining to the voice and cough, when the aperture of the glottis is diminished, whether it be from exudation or spasm, warrants the exclusion of croup, and also laryngismus. From the infrequency of cases of asthma in childhood, the disease is not expected, and hence, when it does occur, other affections more common in early life are suspected until the diagnosis is settled. In the adult, laryngeal affections, accompanied by difficult respiration, viz., œdema glottidis, acute laryngitis, and occasionally spasm of the glottis, are referred to their true situation with still greater facility than in the child. In addition to the circumstances just mentioned, which are equally applicable, the patient's sensations indicate correctly the seat of the obstruction.

Difficulty of breathing, occurring in paroxysms, is incident, in certain cases, to disease of heart, giving rise to what has been known by the name of *cardiac asthma*. The existence of heart disease may be positively ascertained by means of physical signs. It is true that dilatation of the heart occurs as a complication of asthma; but under these circumstances the asthma is known to have existed for a long time, and is generally, if not always, associated with emphysema. The dyspnœa occasioned by embarrassment of the pulmonary circulation differs in several obvious particulars from that caused by obstruction of the smaller bronchial tubes. It is accompanied by palpitation, by marked irregularity in the heart's action, by a sense of distress referred to the præcordia, and a feeling of impending dissolution. The thoracic walls do not contract with inspiration, and the dry bronchial rales are either absent, or do not exist in that degree which characterizes an attack of asthma. Disease of heart, occasioning intense paroxysmal dyspnœa, generally produces more or less habitual difficulty of breathing, or at least dyspnœa is frequently excited by slight causes, such as exercise, etc.

Angina pectoris, which may involve intense dyspnœa, is attended by other symptoms so distinctive that it is not readily confounded with asthma.

Acute bronchitis, occurring in a person affected with emphysema, may give rise to great dyspnœa. Under these circumstances, bronchial spasm is frequently a contingent element of the disease. The paroxysmal increase of the dyspnœa generally depends on this element. But, in so far as the difficulty of respiration proceeds from the bronchitis in combination with the emphysema, irrespective of spasm, it is more persisting than in cases of pure asthma. It pursues a course corresponding to that of the bronchial inflammation, being developed less suddenly than when due to spasm alone, continuing during the stationary period of the inflammatory condition of the membrane, and disappearing gradually in proportion as resolution of the bronchitis takes place. It is accompanied with more cough and expectoration than belong usually to pure asthma, and the matter expectorated presents the characters of mucous inflammation. The moist bronchial rales are more likely to be present than in cases of pure asthma. The existence of the emphysema is ascertained by means of its characteristic signs, which are hereafter to be considered.

The dyspnœa, which forms the most prominent symptom in capillary bronchitis, on a superficial examination, might, for a time, lead the practitioner into the error of supposing the case to be simply an attack of asthma. But a proper investigation should speedily correct this error. Capillary bronchitis generally succeeds, or is coincident with, inflammation affecting the larger bronchial tubes. The local symptoms of bronchitis are present, viz., cough, expectoration of mucus more or less modified, and substernal soreness. The respirations are more frequent. Great acceleration of the pulse is a distinctive feature. The mucous and the sub-crepitant rales are discovered on auscultation. The dyspnœa and associated symptoms are persistent, increasing until the inflammation reaches its acme, and slowly diminishing as the inflammatory condition subsides, presenting thus, in its course, a striking contrast to an asthmatic paroxysm. In capillary bronchitis, as in ordinary bronchial inflammation combined with emphysema, the dyspnœa may present exacerbations which are due to spasm; but the spasm is only an incidental element of the affection, not, as in pure asthma, the primary, and in relation to the bronchial obstruction, the sole pathological condition.

In conclusion, the diagnosis of asthma, in most cases, is very easily made. The fact of its existence is generally well known in the cases which the physician meets with in practice, repeated attacks having been already experienced. It is only when few or no paroxysms have previously occurred that there is room for momentary doubt, and, in such cases, the distinctive symptomatic characters, taken in connection with the absence of the physical evidence of other affections giving rise to embarrassment of respiration, suffice for a prompt and positive discrimination.

As already remarked, instances of simple, uncomplicated asthma are exceedingly rare. Disconnected from even catarrh (dry asthma), and consisting of pure spasm, the affection is to be classed among the curiosities of clinical experience. In most cases of confirmed asthma, the practitioner may expect to discover emphysema, and in a certain proportion of cases, disease of heart. The existence or non-existence of these affections is to be determined by the presence or absence of their diagnostic symptoms and signs.

SUMMARY OF PHYSICAL SIGNS BELONGING TO ASTHMA.

Clear percussion-resonance. Retraction of the base of the chest in front and the epigastrium in the act of inspiration. Vesicular murmur enfeebled or abolished. Sibilant and sonorous rales, with both respiratory acts, loud and diversified, extensively diffused over the chest. Moist rales, in some cases, at the close of the paroxysm.

CHAPTER III.

PNEUMONITIS—IMPERFECT EXPANSION (ATELECTASIS) AND COLLAPSE.

PNEUMONITIS, or inflammation of the pulmonary parenchyma, one of the most interesting and important of the diseases affecting the respiratory organs, occurs under three forms, viz., 1. Lobar pneumonitis, the ordinary form of the acute disease in the adult; 2. Lobular pneumonitis, a form peculiar to children; and 3. Chronic pneumonitis. This division is of practical importance, and each form claims separate consideration. Varieties based on other circumstances, such as the situation and extent of the inflammation, its occurrence as a primary, secondary, or intercurrent affection, etc., will be noticed incidentally so far as is consistent with the scope of this work. Under the head of Lobular Pneumonitis, I shall notice certain morbid conditions which have been hitherto generally considered to belong to that variety of the disease, and which, at present, are most conveniently arranged in the same nosological category, viz., imperfect expansion of more or less of the pulmonary lobules after birth (atelectasis), and collapse.

ACUTE LOBAR PNEUMONITIS.

The ordinary form of acute pneumonitis in the adult is called *lobar*, in contradistinction to lobular pneumonitis, the form peculiar to children. The appellation imports that the inflammation is diffused over an entire lobe of the lungs. This is true, at least in the vast majority of cases, provided the pneumonitis be primary. Secondary or intercurrent pneumonitis may be more circumscribed. Primary lobar pneumonitis is of frequent occurrence. Secondarily the disease is often associated with periodical, continued, eruptive, puerperal and rheumatic fevers, and with purulent infection of the blood. It is developed also as a complication of croup, hooping-cough, acute affections of the heart, encephalon, etc. In these various pathological connections, the vital phenomena, or symptoms, are presented with additions and modifications which serve to enhance the importance of the physical signs in the diagnosis of the disease.

Authors make several varieties of primary lobar pneumonitis, based mainly on semeiological distinctions. So far as relates to diagnosis, it will suffice merely to enumerate the varieties generally recognized.

If the phenomena of the disease indicate purely an acute inflammation unattended by any unusual features, it is frequently styled *frank pneumonitis.* A better title is *simple acute pneumonitis.*

Accompanied by a marked degree of prostration, and more especially with passive or low delirium, it is called *typhoid pneumonitis.* Primitive pneumonitis may present these characters, but it is probable that typhoid and typhous fevers, complicated with inflammation of the lungs, are sometimes confounded with pneumonitis presenting what are ordinarily known as typhoid symptoms.

Occurring in combination with general bronchitis or catarrh, which is apt to be the case, more especially when the latter affections prevail epidemically, constituting influenza, the disease has been distinguished as *catarrhal pneumonitis.*

When it follows a wound, or some external injury, it is *traumatic pneumonitis.*

The term *bilious,* applied in an indefinite sense to various affections, is frequently used in connection with this disease. In its application to cases complicated with icterus it has an obvious significance, which is less apparent when it is extended to cases in which the only evidence of disordered function of the liver are sallowness of the complexion, a greenish or yellow coating of the tongue, dulness of the intellect, and a sense of uneasiness in the epigastrium. In districts known as miasmatic, the disease is called *bilious pneumonitis,* and it is often combined, in these localities, with the phenomena of the periodical fevers.

Pneumonitis is called *latent,* as already stated, when it exists without the local vital manifestations which are usually present. So far as diagnostic symptoms are concerned, it is sometimes remarkably latent; but under these circumstances it is rarely the case that the existence of the disease may not be ascertained by means of the evidence derived from physical exploration.

In a large proportion of cases, lobar pneumonitis is confined to one side of the chest. In a certain proportion of cases, however, the inflammation affects both sides. This constitutes a variety called *double pneumonitis*. When confined to one side, usually a single lobe only is affected, but not very infrequently the inflammation extends over the whole of one lung. This might properly enough be considered a variety of the disease, but it has no distinctive appellation.

The foregoing varieties of pneumonitis, it will be observed, relate to the disease occurring as a primitive affection. It is developed, as already stated, in the course of numerous diseases. Occurring thus secondarily, it is often wanting in diagnostic symptoms, or they are masked by the phenomena of the disease of which it is a complication, so that without the aid of physical signs it would frequently escape detection.

Following Laennec, pathologists agree in describing a series of anatomical changes in acute pneumonitis belonging to three different periods. The career of the disease is divided into stages corresponding to these periods, and each stage or period, during life is characterized by phenomena, vital and physical, which are more or less distinctive. The first period constitutes the stage of *inflammatory engorgement;* the second, the stage of *solidification*, or *red hepatization;* the third, the suppurative period, stage of purulent infiltration, or *gray hepatization*. For a detailed description of the anatomical characters belonging to these different stages, the reader is referred to works which treat of the morbid anatomy of the affection.

The essential anatomical characters which are particularly involved in the production of the physical signs belonging to the disease, are the following. *First stage.* Increased density from engorgement, and the presence of a viscid fluid within the vesicles, which are, as yet, not closed to the entrance of air; co-existing pleuritis. *Second stage.* Solidification in consequence of closure of the greater part of the vesicles of the affected portion of lung by morbid exudation; increased volume of the affected lung, and its incapacity for collapsing in expiration. Exudation of fibrin on the pleura, with more or less liquid effusion within the pleural sac. *Third stage.* Puriform fluid escaping from the cells into the bronchial tubes in greater or less abundance; persisting solidification;

in some cases formation of collections of puriform matter resulting in cavities.

Physical Signs.—The several methods of exploration, with the single exception of succussion, may all furnish morbid phenomena in cases of lobar pneumonitis. The physical signs pertaining to the disease are therefore numerous; but it will be seen that as regards particular phenomena and their combinations, uniformity in the different stages of the disease and in the same stage in different cases does not exist. This want of constancy, however, is rarely the source of much difficulty in the way of diagnosis, although it renders an acquaintance with the variations which are liable to occur, in a practical point of view, highly important.

The percussion-resonance, in the first stage, or stage of engorgement, may be diminished; in other words, the sound over the affected lobe, compared with that elicited in corresponding points on the unaffected side, is more or less dull. This statement accords with the views of most practical writers, but an opposite opinion is held by Skoda. He maintains that the percussion-sound remains unaltered, be the engorgement ever so great, prior to exudation. This was, in fact, the opinion of Laennec. Inasmuch as a fatal result very rarely occurs in the stage of engorgement, opportunities to demonstrate the incorrectness of this opinion, are seldom offered. An instance has fallen under my observation, in which, owing to the disease being developed in a patient affected with great enlargement of the heart, death took place before the local changes, as proved by the autopsy, had advanced to the second stage. In this case, which has been already referred to,[1] the limits of the affected lobe (the lower lobe of the right lung) were easily defined by dulness on percussion, together with the presence of the crepitant rale. In general, however, it is probably true that if the resonance be diminished, in a marked degree, it is to be predicated that the exudation of solid matter has occurred, a result which it is to be borne in mind may follow even within a few hours from the first appearance of local symptoms of the disease. In proportion as the solidification becomes more and more complete, the normal resonance progressively diminishes. Other things being equal, the loss of vesicular resonance is a measure of the amount of solidification. The vesicular resonance may, in fact, be abolished; but it is rarely the case that absolute flatness exists. If a certain proportion of the air-vesicles of the affected lobe do not still contain air, the bronchial tubes are never completely filled with morbid products. The quantity of air which the latter contain is sufficient to prevent total extinction of sonorousness. In this respect the loss of resonance in cases of solidification differs from that which frequently attends large pleural effusions. In the latter the abolition of sonorousness, in other words absolute flatness, is much oftener observed.

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[1] Vide note, page 104.

In proportion as the density of the pulmonary parenchyma is increased, first by engorgement, and next by solid exudation, the sense of resistance felt in percussing over the affected lobe is greater than in corresponding situations on the healthy side of the chest. This sign exists in a marked degree in the second stage of pneumonitis, and constitutes a means by which, to some extent, the amount of solidification may be estimated.

The resolution of the inflammation is accompanied by a return of the vesicular resonance, and the normal elasticity. Percussion, thus, enables us to determine the progress made in the removal of the solid deposit, and the completeness of the final restoration of the affected portion of the pulmonary organs.

The acoustic phenomena elicited by percussion which have just been mentioned, relate mainly to *vesicular* resonance. The effects on the sonorousness of the chest, which may be produced by the anatomical changes in pneumonitis, are not fully embraced in the foregoing description. Over lung completely solidified by intra-vesicular deposit, whatever sonorousness remains must, of course, be non-vesicular, and consequently tympanitic. Exclusive of the rare instances in which, under these circumstances, there exists absolute flatness, the vesicular is replaced by a tympanitic resonance, which may be more or less marked. The term tympanitic expressing an abnormal quality of sound, irrespective of its intensity, the resonance may be in a marked degree diminished, and, indeed, but feebly appreciable, while its non-vesicular character is yet sufficiently apparent. In the second stage of pneumonitis, then, if there be not total extinction of sonorousness, in connection with a greater or less amount of dulness on percussion, a tympanitic resonance will be observed.

In some instances the vesicular resonance is replaced by a strongly marked tympanitic sound. In intensity and clearness, the sonorousness over the solidified lung may even exceed the resonance on the unaffected side. Its non-vesicular character and highness of pitch are the more striking, contrasted with the normal resonance, in proportion to its intensity. The sense of resistance on percussion, or pressure, in addition to other circumstances, serves to distinguish the tympanitic resonance occurring over solidified lung, from that incident to some cases of emphysema, and from all cases of pneumo-hydrothorax, the thoracic parietes retaining their elasticity in the latter forms of disease. In cases of pneumonitis affecting the left lung, a tympanitic resonance may be due to distension of the stomach with gas. This source is often sufficiently evidenced by the gastric character of the sound, viz., notable acuteness of pitch, and a metallic quality. In some instances in which the upper as well as lower lobe is solidified, the gastric note is manifested at the inferior portion of the chest, while over the superior part the tympanitic resonance is lower in pitch and without any metallic tone; and a tympanitic resonance, in cases of pneumonitis affecting the entire left lung, may be marked over the upper and middle portions, while flatness exists at the base. On the right side a tympanitic resonance may be transmitted from the distended colon; but it is observed over the superior and middle thirds on this side, in cases in which below the upper boundary of the liver percussion elicits a flat sound. The tympanitic resonance due to solidification of lung, is much oftener marked in cases in which the upper lobes are affected, on the anterior surface of the chest, and especially over the middle third. Excepting cases in which, on the left side, a gastric sound is transmitted, it is rare that on the posterior surface more than an obscure or feeble non-vesicular resonance is discoverable.

In cases in which an entire lung is solidified, I have observed a tympanitic resonance in different parts, varying not only in intensity, but in pitch. Thus in a case in which the right lung was solidified, the percussion-sound at the summit was dull, but distinctly tympanitic and high in pitch. Over the middle third the pitch was considerably lower, but the tympanitic resonance more intense. In the axillary region the tympanitic quality was also marked, and the pitch still lower than over the middle anterior third.

In some instances the tympanitic resonance persists from day to day, during the course of the disease, gradually diminishing, receiving by degrees the vesicular quality of sound, becoming vesiculo-tympanitic, and finally assuming the normal character. But in other instances marked variations are observed at the examinations repeated on successive days: on one day the sound may be dull, amounting almost to absolute flatness, and on the next day it may become highly tympanitic. I have observed the change from a marked degree of tympanitic sonorousness to great dulness, to occur within the space of an hour. Without designing to discuss the subject of the rationale of the phenomenon under consideration, I will simply remark that these fluctuations, except when the sound is of gastric or intestinal origin, point to the bronchial tubes as the source of the tympanitic resonance in cases of solidification. The varying condition of the tubes as respects the accumulation of mucus or other morbid products, will perhaps account for the existence of sonorousness at one time, and dulness amounting nearly to flatness at another time. The situation in which the tympanitic resonance is apt to be most marked, viz., over the larger tubes, favors the same explanation.

In cases of pneumonitis affecting the lower lobe, the percussion-resonance over the unaffected lobe on the same side is frequently, if not generally, modified. The sonorousness is greater than in corresponding situations on the opposite side; it is higher in pitch, and is vesiculo-tympanitic in quality. These characters are more marked on the anterior surface of the chest, but they may also be apparent posteriorly in the upper scapular region. On the side free from disease the resonance is usually strongly marked, and highly vesicular.

By means of percussion the limits of the inflammation may generally be defined without difficulty. The change from the vesicular or a vesiculo-tympanitic resonance, to dulness or a non-vesicular sonorousness, is generally abrupt, and the line of demarcation between the healthy and solidified lung is easily traced on the chest. In view of the fact that lobar pneumonitis extends over an entire lobe, and in the majority of cases is limited to a single lobe, the line bounding the limits of the affected portion of the lung will, as a rule, be found to pursue a direction coincident with that of the interlobar fissure. Thus if the lower lobe be affected, the line intersecting the several points at which the change in the percussion-sound is observed, extends obliquely upward and outward, from between the fifth and sixth ribs, in a direction toward the vertebral extremity of the spinous ridge of the scapula,—this being the situation of the fissure separating the upper and lower lobes on the left side, and the middle and lower lobes on the right side. On the right side, in cases in which the inflammation extends to the middle lobe, the line pursues a direction upward and outward from the fourth cartilage. This is a point not only of interest, but one which may be in some instances of importance in diagnosis. In the absence of the auscultatory phenomena distinctive of solidification of lung, which, although generally present, may yet be absent, the question will perhaps arise whether marked dulness or flatness on percussion be not due to liquid effusion; in other words, the differential diagnosis between pneumonitis and pleuritis is to be made. Now, if under these circumstances, the line denoting the limits of the dulness or flatness be found to occupy the situation of the interlobar fissure, while the body of the patient is in a vertical position, the question may be considered almost or quite settled.

With the resolution of the inflammation, in proportion as the solid exudation disappears, the vesicular resonance, as already stated, returns. This is gradual, though frequently much progress is made within a short space of time. The dulness is sometimes observed to lessen materially in twenty-four hours. It is, however, a long time before complete equality in the resonance of the two sides is restored; a marked disparity may exist for months after the patient has apparently recovered perfect health; and it is probable that in some instances the symmetry of the two sides as respects percussion-resonance is never fully regained.

Auscultation, in most cases of pneumonitis, furnishes numerous and important signs. As the inflammation does not invade simultaneously the whole of a lobe, but, commencing at one or more points, advances thence in all directions, a certain period may elapse before any positive auscultatory phenomena are discoverable. This will be the case especially if the points of departure of the inflammation be centrally situated. The healthy parenchyma surrounding the portion inflamed, presents the phenomena originating in the latter from reaching the ear. Under these circumstances, according to Fournet, the existence of pneumonitis, taking into account the symptoms, may sometimes be predicated on an exaggerated respiratory murmur over a portion of the chest. He states that the vesicles surrounding an inflamed portion of a lobe take on a supplementary activity, and give rise to an abnormally loud respiration. It is stated also by Stokes, that the first effect of inflammation prior to the production of the crepitant rale, is an exaggerated murmur. On the other hand, Grisolle states that the effect of inflammation upon the adjoining lung-substance is oftener to diminish its activity, giving rise to an abnormally weak respiration. Both these statements, although they may at first appear to be contradictory, are correct; in other words, the respiratory sound in the immediate vicinity of an inflamed portion may be either exaggerated or weakened. The opportunity of observing one or the other of these effects, is occasionally presented in cases in which the existence of central pneumonitis is indicated by characteristic symptoms prior to the development of distinctive signs, which shortly make their appearance, showing that the inflammation has extended from its central situation to the surface. The opportunity is also presented in cases in which the inflammation passes from one lobe to another, gradually invading the latter. I have noted, under these circumstances, in different cases, both exaggerated and weakened respiration; and in the same case I have observed on two successive days, in the same situation, first exaggerated, and next weakened respiration. In some instances, while the area of the inflamed lung is limited, especially if it be situated near the surface, a broncho-vesicular respiration precedes the appearance of other signs.

The earliest and most characteristic of the positive signs of pneumonitis in most instances, is the *crepitant rale.* This sign is incident to physical conditions belonging to the primary local effects of inflammation, and is heard when the inflamed portion is sufficiently large, and near enough to the surface for the sound to be transmitted. Contrary to the opinion of Skoda, it is present in a very large majority of the cases of pneumonitis. Out of forty-four cases taken in regular order with a view to an analysis of the recorded physical signs, in thirty-two a crepitant rale was observed, and in twelve its presence was not noted. But of these twelve cases, in eight a single examination only was made, and in all at a period more or less remote from the commencement of the disease. It is probable that examinations repeated, and made at an earlier period, would not have been negative as regards this sign in the greater proportion of the few instances in which it was not discovered. Of 149 examinations, in forty-five cases, made at different periods in the progress of the disease, the presence of the rale is noted in eighty-five, and its absence in sixty-four. The collection of cases analyzed did not embrace cases of lobar pneumonitis occurring in infancy. My observations lead me to concur with others in the opinion that the crepitant rale is much less constantly present in children than in adults. It is perhaps oftener absent than present in infant life. The constancy of the rale in acute primitive pneumonia, affecting the adult, is shown by the much more extensive researches of Grisolle. This author, in his treatise on pneumonia, based on an analysis of 373 cases, states that he has only met with four instances in which this sign was not discovered at some period during the course of the disease. Different cases, however, present great differences as respects its abundance, loudness, proximity or remoteness, diffusion and continuance. The period when it is usually most abundant and loudest is early in the disease, prior to the time when the physical evidences of solidification, more or less complete, are present; that is to say, during the first stage. During this stage, in some instances it exists in a marked degree, occupying the whole or the greater part of the inspiratory act, in other instances being comparatively faint, and heard only at the end of inspiration. In some instances, even during this stage, it is not discovered in ordinary respirations, but is developed by forced breathing, and especially by the deep inspirations which precede and follow an act of coughing. In a small proportion of cases the methods just named fail to produce it, and the diagnosis must be based on other signs. It may be detected in the majority of cases, for a greater or less period, after the disease has advanced to the second stage. It is then, generally, confined to the end of the inspiratory act, and much more frequently requires for its production that the force of the act be voluntarily increased. In both stages it may be heard at different situations over the affected lobe or lobes, or it may be confined to a few points. It is much more apt to be diffused in the first stage, this, in fact, being very rarely the case in the second stage. Sometimes it seems to arise in close proximity to the ear, and at other times it apparently originates at a distance. It may be appreciable during the whole career of the disease, even into convalescence, or it may cease at a period more or less removed from this epoch.

Laennec described the crepitant rale as generally disappearing in the progress of the disease, and afterward returning during the period of resolution. This must be ranked among the instances (singularly few in number), in which the observations of the founder of auscultation were biassed by speculative notions. Moreover, the distinctive traits of the true crepitant rale were not fully known by Laennec, and, hence, it was confounded by him with the sub-crepitant. The observer who seeks by daily explorations during the career of pneumonitis to verify the *crepitant rale redux*, will very often meet with disappointment. The crepitant rale, as just stated, may continue through the whole course of the disease. It may disappear and reappear at irregular intervals. I have known it to become more marked after the lapse of several days than at an early period in the disease. I have even observed it to become developed as late as the 17th day, when it had not been previously discovered; but the regular occurrence of a *returning crepitant rale*, as a harbinger of recovery, cannot with propriety be said to constitute a portion of the natural history of pneumonitis. As a rule, when the rale, after continuing for a greater or less number of days, disappears, it is not reproduced, except as the sign of a new focus of inflammation.

The sub-crepitant rale—a bronchial, not a vesicular rale, conveying the idea of small but unequal bubbles, wanting the equality, the dryness, and the extreme fineness of the true crepitant, and not limited to the inspiratory act,—may occur at any period of the disease. Present on both sides of the chest, in the early stage, and diffused especially over the posterior base, it denotes the coexistence of capillary bronchitis. The two rales may be combined and distinguished from each other, the crepitant appearing at the end of the inspiration, and the sub-crepitant in both acts. This I have observed in a case to which reference was made in treating of the crepitant rale in Part I. Exclusive of the very rare instances in which pneumonitis and capillary bronchitis are associated, the sub-crepitant rale is much more likely to occur at a late period in the disease, during the progress of resolution. Developed under these circumstances it is, in fact, the returning crepitant rale of Laennec. But its appearance is by no means constant. Indeed it is wanting in a large proportion of cases.

The other bronchial rales, both moist and dry, are all liable to occur in cases of pneumonitis. Since, however, as a general remark, they imply the coexistence of bronchitis, which, save in a limited extent, is only an occasional complication, the occurrence of the sibilant, sonorous, and mucous rales, as prominent physical phenomena, being limited to a small proportion of cases only, is in accordance with the pathological laws of the disease. Clinical observations show that these rales are far from being common in cases of pneumonitis. In the majority of cases, examinations, repeated at different periods, do not show their existence, except occasionally, as transient phenomena. It is rare for them to be prominent in cases in which the disease does not advance beyond the second stage. In the third stage, the moist or bubbling rales are much more likely to occur than in the two preceding stages.

The infrequency of the occurrence of the bronchial rales, irrespective of the sub-crepitant, in ordinary cases of pneumonitis, is shown by the following: of 148 examinations at different periods in forty-five cases, a sibilant rale is noted in seven, a sonorous in six, and a mucous in three instances.

A friction-sound is sometimes discovered in auscultating over an inflamed lobe, but the proportion of instances in which this sign occurs in pneumonitis is extremely small. In forty-five cases, out of 149 examinations it is noted in five examinations, made in three cases.

In addition to adventitious sounds, the vast majority of cases of pneumonitis are characterized by important modifications of the respiratory phenomena. The modifications constituting the bronchial and the broncho-vesicular respiration, very rarely fail in being developed during the course of the disease. The bronchial respiration is absent in but an exceedingly small proportion of instances. Of the forty-five cases which I have selected for analysis, commencing with the last case recorded, and rejecting none till this number was completed, in five either the examinations were begun too late in the disease, or the records are imperfect with respect to this point. Excluding these five cases, out of the remaining forty the bronchial respiration was more or less marked in thirty-seven. In two the modification did not exceed that constituting the broncho-vesicular respiration; and in the other exceptional case the patient died on the second day in the stage of engorgement, the disease being complicated with dilatation of the heart. In the large collection of cases analyzed by Grisolle (373), the bronchial respiration was observed to cease two days before death in one, and was not developed in another of two cases in which the inflammation extended over an entire lung; and of the cases in which the inflammation was limited to a single lobe, it was wanting in nine.[1] The bronchial respiration is a sign of solidification. In connection with percussion it affords evidence of the progress of the disease to the second stage. It denotes the continuance of the solidified state of the lung, indicating by its gradual disappearance the removal of the solid exudation. Other things being equal, its intensity is probably in proportion to the completeness of the solidification. As regards its development, it occurs much earlier in some cases than in others. I have known it to take the place of the vesicular murmur in the space of twenty-four hours. It may not appear till the second or third day after the date of the attack, or even still later. In a very large proportion of hospital cases it is found when patients first come under observation. If we have an opportunity of watching its development, we may observe that the transition from the vesicular murmur is not abrupt, but takes place gradually, the broncho-vesicular modification preceding a well-marked bronchial respiration; that is to say, the inspiratory sound loses the vesicular quality by degrees, until at length it becomes entirely tubular or blowing. In some instances the presence of the crepitant rale prevents us from appreciating a well-marked alteration affecting the inspiration, until the sound becomes distinctly bronchial, the rale then either ceasing, or being heard only at the end of the act. In the progress of the disease the bronchial respiration attains its maximum, as respects intensity and completeness; continues without much diminution or alteration for a certain period, and gradually becomes less intense and complete, at length merging into the broncho-vesicular respiration.

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[1] Op. cit.

The bronchial respiration in acute lobar pneumonitis, is not a variable or fluctuating sign. As a rule, after it is developed, it may be discovered at each successive examination, until, in the progress of the disease, it declines and disappears. There are, however, occasional exceptions to this rule. I have known it to be absent and shortly reappear, its temporary cessation being perhaps due to casual obstruction of the tubes. Such obstruction during the period of the disease when the bronchial respiration may be expected to be present, rarely occurs in ordinary cases of pneumonitis. During the progress of the disease in 40 cases, the bronchial respiration existed in 107 out of 146 examinations made on different days. Of the remaining 39 cases, in 7 there was absence of respiratory sound, and in 32 the modification came under the denomination of broncho-vesicular. These enumerations show the persistency of this sign in cases of pneumonitis.

The intensity of the bronchial respiration and certain of its characters, vary in different cases. Generally cases of pneumonitis present, for a greater or less period, all the elements which this physical sign in its completeness embraces, viz., a tubular, shortened, high-pitched (occasionally metallic) inspiration, followed, after an interval, by an expiration, prolonged, more intense, and higher in pitch (oftener metallic) than the sound of inspiration. Of 27 cases, in the records of which the bronchial respiration is described as respects the presence or absence of these several elements, in 24 they were all present for a period greater or less. In two cases a tubular inspiration existed without any sound of expiration, and in one case an expiratory sound existed alone. Enumerating the successive examinations made on different days in these 27 cases, and the result is as follows: Out of 86 examinations, in 65 all the elements of the bronchial respiration were present. Of the remaining 21 examinations a tubular inspiratory sound, without a sound of expiration, existed in 11, and an expiratory, without an inspiratory sound, in 10. In six of the latter 10 instances, however, the inspiratory sound was drowned by the crepitant rale.

It was stated by Jackson, and it is repeated by Grisolle, that in the development of the bronchial respiration the abnormal modification is first manifested by a prolonged expiration. The earliest change is, to say the least, generally more obvious in expiration than in inspiration. The former frequently is not only prolonged, but becomes intense and high in pitch, while the latter is comparatively feeble, and still retains more or less of the vesicular quality—in other words, is broncho-vesicular. It is rarely, however, if ever, the case, that in connection with a prolonged, intense, high-pitched expiration, the inspiratory sound is not at the same time more or less altered, being less vesicular and higher in pitch than on the opposite side of the chest, and also shortened or unfinished. On the other hand, at a later period, when the bronchial is about to merge into the vesiculo-bronchial respiration, the change is frequently, if not generally, first manifested in the inspiration, which becomes weaker and assumes more and more the vesicular quality, while the expiration remains prolonged, high-pitched, and relatively more intense. At a still later period the expiratory sound may disappear, leaving the inspiration still less vesicular and higher in pitch than the normal murmur.

The transition from an intense bronchial to a broncho-vesicular respiration, like that of the percussion-sound from marked to moderate or slight dulness, is gradual; yet in the one, as in the other case, frequently a considerable alteration is often observed to take place within a short space of time. A striking diminution in intensity of the bronchial respiration, and the conversion of a purely tubular to a vesiculo-tubular inspiration, are sometimes observed by comparing the examinations of two successive days. A return to the normal vesicular murmur is rarely complete for some time after convalescence is established. Even when the patient is sufficiently restored to be out of doors, the respiration over the affected lobe, or lobes, often continues broncho-vesicular. When the characters of the bronchial and the broncho-vesicular respiration have nearly or quite disappeared, the respiratory sound over the affected lung is often abnormally feeble, being sometimes scarcely appreciable except the breathing be forced. Fournet states that the bronchial respiration is apt to be succeeded in the affected portion of lung by an exaggerated vesicular murmur. Judging from the cases that I have observed, I should say that the rule is directly the reverse. With respect to this point, the following are the observations of Grisolle :—Of 103 convalescents discharged from hospital, between the twentieth and fifty-fifth days of the disease, 37 had no morbid signs; in 36 the respiration was weak; in 14 the respiration was slightly blowing; and in 16 there existed sub-crepitant or other bronchial rales.[1]

In the majority of cases of pneumonitis the disease being limited to the lower lobe of one lung, the abnormal modifications of the respiratory sounds, as well as other physical phenomena, are to be sought for especially on the posterior surface of the chest below the spinous ridge of the scapula. They are also manifested on the lateral surface below a diagonal line corresponding to the interlobar fissure. Anteriorly the bronchial respiration, and also the crepitant rale, may be discovered at the base of the chest, but it not infrequently happens that over the small portion of the lower lobe which extends in front, auscultation fails to detect any morbid phenomena. Posteriorly and laterally, if the stethoscope be employed by passing the instrument over successive portions of the chest from above downward, the change from the vesicular murmur to the bronchial respiration is found to be abrupt, not gradual. If the line indicating the situation of the interlobar fissure have been already traced by the change in the percussion-sound, the transition from the vesicular murmur to the bronchial respiration will be found to take place on the same line. The limits of solidification may thus be defined by auscultation as well as by percussion, and it is in some cases easier to trace the boundaries by means of the former than by the latter method. On the back, the characters of the bronchial respiration are shown in striking contrast by auscultating alternately above and below the spinous ridge of the scapula.

If the whole lung become affected, the different lobes being attacked in succession, the bronchial respiration will present differences as respects intensity, and other characters, in different situations. On the right side in front, I have observed a striking disparity in pitch and other points over the upper, middle, and lower lobes, the pitch and intensity diminishing from above downward in these three situations. The same disparity I have also observed over different points within the boundaries of the same lobe. In accordance with the fact that when an entire lung is affected, even if the upper lobe be invaded secondarily, resolution takes place first in this lobe, the bronchial respiration will be found to continue longer posteriorly below the spinous ridge of the scapula, than over the upper and middle thirds in front. It will be found frequently, if not generally, to continue longer in the lower scapular, than in the infra-scapular region; but this is probably owing to the proximity in the former region to the larger bronchial tubes.

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[1] Walshe, op. cit.

Over the unaffected side in cases of pneumonitis the respiratory murmur is frequently intense, and the vesicular quality highly marked, in short, exaggerated. If the affection be limited to a lobe, according to Fournet, the respiratory sound over the unaffected lobe is even more exaggerated than on the opposite side on the chest. So far as my experience goes, the reverse of this is nearer the truth. The murmur over the upper lobe on the affected side is sometimes extremely feeble, almost null, so that conjoined with a tympanitic percussion-resonance, the physical evidences of emphysema are present.[1] I have, however, observed an exaggerated respiration in the upper lobe when the lower was solidified, the intensity being notably greater than over the upper lobe in the unaffected side.

Auscultation furnishes important *vocal phenomena* in pneumonitis. In the second stage, over the solidified lung, bronchophony occurs in a very large proportion of cases. Of 27 cases in the histories of which is noted either the presence or absence of this sign, it was observed in 25, and not discovered in two. By bronchophony, it will be borne in mind, I do not mean simply exaggerated vocal resonance, but a greater or less apparent approach of the voice to the ear of the auscultator. In the great majority of instances this increased proximity of the voice is accompanied by an abnormal resonance or reverberation, but not invariably. It is not very infrequently the case that the approach of the voice and the reverberation do not correspond, as respects relative intensity. The voice sometimes seems very near the ear when the resonance is but little exaggerated; and, on the other hand, the resonance may be intense while the voice remains as distant as in the normal condition. An increased vibration or thrill is frequently felt by the ear applied either directly to the chest, or to the stethoscope. The latter may or may not accompany the bronchophony and vocal resonance, and it is sometimes present when the other vocal phenomena are wanting. In intensity there is not a uniform correspondence between it and the vocal transmission and resonance, more than exists between the two latter. The vibration or thrill, indeed, may be greater on the unaffected side of the chest in pneumonitis, when bronchophony and increased reverberation are marked over the solidified lung. The bronchophony in different cases of pneumonitis is variable in degree. The vocal sound appears in some instances to emanate directly beneath the ear or stethoscope, and between this maximum and a slight approximation appreciable only by a careful comparison of the two sides of the chest, every grade of intensity may be observed in different cases, and sometimes in a series of successive examinations in the same case. When the bronchophony has a marked intensity, or, in other words, is strong, the vocal sound in some instances appears to strike the ear with a certain force, giving rise to a sense of concussion or shock, like that felt when auscultation of the voice is practised over the trachea. The pitch of the vocal sound in some instances is notably high, exceeding that of the tracheal voice. It acquires sometimes a metallic tone. Other things being equal, the maximum of the degree of intensity to which either bronchophony or exaggerated vocal resonance attains, in the progress of pneumonitis, denotes the greatest amount of solidification. It coexists, therefore, with the greatest loss of vesicular resonance on percussion, and with the maximum of intensity of the bronchial respiration. As the disease pursues its course, these vocal phenomena reach their maximum by degrees, and gradually become weaker as the solidification decreases in the progress of resolution. In this retrograde course, when bronchophony and exaggerated resonance are associated, the former disappears first, the latter continuing to be more or less marked for a period varying considerably in different cases. With respect to the vocal, as well as the respiratory phenomena indicative of solidification, often a marked diminution is observed to occur within a short space of time, and occasionally they disappear rather abruptly.

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[1] In Part I, I have suggested the inquiry whether an emphysematous condition may not serve to account for the vesiculo-tympanitic resonance which so frequently exists over the upper lobe when the lower is solidified.

The duration of the vocal signs in different cases of pneumonitis is variable. Of 88 examinations, made on different days in 27 cases, bronchophony existed in 61 and was absent in 27. The examinations in which it was absent were mostly made during the latter part of the disease, the sign having existed, but disappeared. When, however, it is once developed, it is a persistent sign until it disappears as the consequence of the progress in resolution; that is, it is generally found at each successive examination. This statement is in opposition to the opinion of Skoda, who maintains that the bronchophonic voice is constantly fluctuating, sometimes even appearing and disappearing in the course of a few moments. An analysis of a series of recorded examinations shows this opinion to be incorrect. Of the 88 examinations in 27 cases just referred to, in but two instances was the sign absent when its existence was noted at the examination preceding, and also that succeeding the one on which it was found to be wanting.

Bronchophony in the same case, at the same moment, is by no means equal at different points over the affected lobe or lobes. Its highest intensity is in cases in which the upper lobe is affected, over the portion of the summit of the chest in front, situated nearest to the largest bronchial divisions. Posteriorly, when the lower lobe is affected, it is generally more marked over the lower scapular, than in the infra-scapular region. Well-marked bronchophony may exist over the larger bronchial tubes, while at a little distance the vocal resonance is simply exaggerated. It is not uncommon to find bronchophony over the scapula, and exaggerated resonance below the scapula.

By means of an abrupt change in the vocal phenomena, limiting by the use of the stethoscope the space from which the sounds are received, the interlobar fissure, in cases of pneumonitis affecting a single lobe, may be often traced on the chest as well as by the percussion and the respiratory sounds, in the manner already described; and when this has been done by means of the two latter phenomena, the auscultation of the voice furnishes another method of verification.

The transmission of the articulated voice or speech, in other words pectoriloquy, is a physical sign occasionally observed in cases of solidification from pneumonic inflammation. In 2 of 27 cases words (numerals) spoken aloud were transmitted. In 2 other cases whispering pectoriloquy was complete, and in several instances whispered words were imperfectly transmitted. Contrary to the opinion of Walshe, who regards whispering pectoriloquy as eminently distinctive of a cavity, I have found it oftener present in connection with solidification than the transmission of words spoken aloud.

When whispered words are not transmitted, a *souffle*, or puff is generally produced over solidified lung, which claims the attention of the auscultator. Under certain circumstances in pneumonitis, and other affections involving solidification, *e. g.* tubercle, it constitutes a valuable physical sign, its significance being the same as bronchophony and the bronchial respiration. It is valuable, not only as confirmatory of the fact of solidification, associated with the signs just named, but still more because it may be developed in some instances in which they are wanting. The *souffle* or puff, accompanying the act of whispering, and heard over solidified lung, is more intense than that over healthy lung in corresponding situations on the opposite side of the chest, and acute or higher in pitch. The contrast is as striking as between a vesicular and a well-marked bronchial respiratory sound. In some cases it is distinctly marked over a portion of lung solidified, and no sound is developed over a corresponding situation on the healthy side. Owing to the small number of instances in which the bronchial respiration and bronchophony are absent in ordinary pneumonitis, this vocal sign is of less diagnostic importance than in other affections in which other phenomena denoting abnormal density of lung are less commonly present.

In some cases of pneumonitis, it is stated, the voice in passing through the chest acquires the ægophonic characters, viz., tremulousness and acuteness of pitch. Some observers, indeed, profess to have discovered strongly marked ægophony in pneumonitis; and it is claimed that this vocal sign may occur in cases in which there is no pleuritic effusion. The latter point it is difficult to establish, since, if in fatal cases, no liquid is found, it may have existed during life and been absorbed. I have never met with a well-marked bleating intonation of the voice in pneumonitis; but the elevation of pitch has in several instances attracted my attention.

Inspection of the chest discloses, in a certain proportion of cases of pneumonitis, abnormal appearances deserving attention. Coincident with the attack, the movements of the affected side may be visibly restrained, attributable, at this stage, to the pleuritic pain which is generally present in the early part of the disease. At a later period, during the second stage, if a single lobe be affected, a disparity in expansion-movement at the inferior portion of the chest is sometimes obvious, and in other instances not apparent. If the entire lung become affected, a disparity is frequently well marked. It is more marked if the breathing be labored, or voluntarily forced.

Under these circumstances the three types of breathing may be conspicuous on the unaffected side, while they are but feebly manifested on the side diseased. The deficient expansion of the affected side when pain has ceased to be a prominent symptom, in other words in the second stage, is attributable to the augmented size of the lung, and the loss of its contractility. The side, in fact, is in a measure dilated permanently, and the incompressibility of the solidified lung prevents its contraction to the same extent as in health. The disparity under these circumstances is increased by the healthy side taking on a supplementary activity.

This statement is in opposition to the opinion of Grisolle, who, exclusive of instances in which the movements are restrained by excessive pain, does not admit a disparity between the two sides in this respect.

The intercostal depressions are not lost, except in certain cases characterized by the presence of liquid effusion.

After the stage of resolution, more or less contraction of the chest may be evident on inspection. It has been doubted by high authority[1] whether this ever occurs except as the sequel of pleuritic effusion which coexisted with pneumonic solidification. On this point my own observations lead me to accord with the opinion of Stokes and Walshe, which refers the contraction succeeding pneumonitis in certain cases, to the diminished bulk of the affected portion of the lung in consequence of the removal of the solidifying deposit, and the contraction of the plastic exudation on the surface.

With regard to mensuration, my recorded observations do not furnish sufficient data to serve as the basis of any conclusions. Walshe states that in a minority of cases he has found positive, though slight, increase of size at the base of the chest on the affected side in the second stage of the disease. The occurrence of contraction of the affected side after recovery is indubitable. The only question relates to the pre-existence of liquid effusion in all such cases. On this question an opinion has just been expressed.

Finally, palpation furnishes physical phenomena in different cases of pneumonitis, somewhat contradictory. As a rule, the vocal fremitus is increased, in the second stage of the disease, over the solidified lung. But the exceptions to this rule are not very infrequent. In some of the exceptional instances no disparity as respects this sign is appreciable on comparing the two sides of the chest. In other instances the fremitus is greater on the unaffected side. If the left lung be the seat of the disease, the explanation may be that the fremitus over the solidified lung is not increased, as naturally it is frequently more marked on the right than on the left side. But I have observed the fremitus to be greater on the left side, when the pneumonitis was seated on the right lung. This shows that an effect of solidification, under certain circumstances, is a diminution of the natural fremitus. Instances of this description are, however, it is probable, extremely rare.

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[1] Woillez, Grisolle.

Diagnosis.—The space which has been devoted to the consideration of the physical signs belonging to pneumonitis may lead the reader not practically conversant with the subject, to suppose that the diagnosis involves greater difficulties than actually exist. The truth is, with a knowledge of the semeiological phenomena of the disease, and an acquaintance with the diagnostic features of other affections presenting some characters in common, it is recognized with promptness and positiveness in the great majority of cases.

If a person be seized with a chill, which is followed by high febrile movement, and lancinating pain in the chest, referred to the neighborhood of the nipple; accompanied by cough, with an adhesive, rusty expectoration, and a well-marked crepitant rale is found on auscultating the posterior surface of the chest on one side, it is at once evident that he is attacked with pneumonitis seated in an inferior lobe. This group of diagnostic phenomena is presented in a pretty large share of the cases of simple acute pneumonitis at the time when they first come under the observation of the medical practitioner. Of these phenomena the characteristic expectoration and the physical sign may be said to be pathognomonic. A viscid expectoration, containing a variable quantity of blood in intimate combination, is a symptom belonging exclusively to inflammation of the pulmonary parenchyma. If this statement be not correct in the most rigorous sense, it may at all events be practically so regarded.[1] So with regard to the crepitant rale, if we are sure of its presence, that is, if the characters which distinguish it from other rales are clearly made out, and it occurs in the situation and in connection with the symptoms just mentioned, it affords positive proof of the existence of pneumonitis. It is only when more or less of the distinctive features of the disease are obscure or wanting, that there is room for delay and doubt, as regards the diagnosis.

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[1] According to the observations of Dr. Remak, of Berlin, if the sputa from a patient affected with pneumonitis, after having been macerated for some time in water, be placed on dark-colored glass, and carefully examined, minute fibrinous concretions may be discovered, which are probably casts moulded in the minute bronchial ramifications. Dr. Remak succeeded in discovering fibrinous casts in 50 successive cases, between the third and seventh days of the disease. Other observers have not met with equal success. Vide Art. by Dr. Da Costa, Am. Jour. of Med. Sciences, Oct. 1855.

The group of phenomena characterizing the access of pneumonitis, is sometimes incomplete during the development of the disease, while the inflammation is confined to a limited space, perhaps centrally situated, and gradually extending over the lobe. Under these circumstances the rusty expectoration may be present, indicating the nature of the affection before any positive physical evidence is discoverable. In a case in which the symptoms denote some acute pulmonary disease, if the characteristic expectoration be observed, physical exploration, although at first negative, may be expected soon to furnish the signs of pneumonic inflammation, and should therefore be often repeated. In such a case, should the respiratory murmur on one side be found abnormally feeble or exaggerated, or if the sound is somewhat changed, presenting the characters of the broncho-vesicular modification, these physical phenomena, although not intrinsically significant of pneumonitis, taken in connection with the associated circumstances, render it probable that inflammation exists, but as yet confined to a portion of the lobe. On repeating the examinations, a crepitant rale is at length satisfactorily made out, and the fact of pneumonic inflammation is then established.

The characteristic expectoration, however, is by no means uniformly present in cases of pneumonitis, and if not altogether absent, it is not always among the earliest symptoms of the disease. Under these circumstances, if the pathognomonic sign, viz., the crepitant rale, be discovered, the diagnosis is promptly made. But it will sometimes happen that both these characteristics are absent: a little delay is then requisite, until the symptoms and signs incident to the second stage of the disease become developed. This delay is much oftener requisite in cases of lobar pneumonitis affecting children. In children the expectoration is generally swallowed, and hence its diagnostic characters are unavailable. The crepitant rale is also frequently wanting. Adding to these circumstances the difficulty frequently experienced in making a satisfactory exploration of the chest, owing to their timidity or restlessness, the means of determining positively the character of the disease are often insufficient until the signs of solidification are apparent.

Pneumonitis, as has been seen, in general runs rapidly into the second stage. In this stage new diagnostic features are added. The rusty expectoration and crepitant rale continue, but frequently become less marked. The added symptoms and signs pertain chiefly to the solidified condition of the lung. The function of hæmatosis being compromised in a greater degree, the respirations are accelerated, *cæteris paribus*, in proportion to the completeness of the solidification and the extent of the pulmonary organs involved. The alæ nasi dilate, and there may be lividity of the prolabia and face. The cheeks often present a circumscribed flush. The acceleration of the breathing is out of proportion to the frequency of the pulse. The physical evidences of solidification are easily ascertained. On percussion, the chest over the inflamed lobe is found to be notably dull, with a marked increase of the sense of resistance and diminished elasticity. In the majority of cases, as has been repeated more than once, a single lobe only is inflamed, and this is the lower lobe. It is important for the student to recollect the relations of the inferior lobe to the anterior and posterior surfaces of the chest. So small a portion extends in front, that in many, if not most instances, physical examination anteriorly is comparatively unimportant. The signs emanating from the affected lobe are to be sought after behind, below the spinous ridge of the scapula. The interlobar fissure crosses the lateral surface of the chest obliquely, and its situation is generally determinable by the abrupt change in the percussion-sound. The fact of a line indicating the limits of dulness on the lateral surface of the chest, corresponding in direction with the interlobar fissure and not varying with the position of the patient, is a diagnostic feature in itself almost conclusive. Assuming the inferior lobe to be the seat of solidification, in the lower scapular and infra-scapular regions, and laterally below the line of the interlobar fissure, more or less of the characters embraced in the bronchial respiration are present in the vast majority of cases. Bronchophony or exaggerated vocal resonance is present also, with few exceptions; also the bronchial *souffle* or high-pitched puff with whispered words. In the larger proportion of instances, at least in adults, the evidence afforded by auscultation of the respiration and voice is corroborated by an increased vocal fremitus. If the upper lobe be primarily the seat of the inflammation, the physical phenomena will, of course, be manifested within its limits, viz., in front above the fourth rib, behind in the upper scapular region, and laterally above the interlobar fissure. The occurrence of highly marked tympanitic or tubular percussion-resonance over solidified lung, especially anteriorly when the superior lobe is affected, is a point not to be forgotten. It is superfluous to add that if the inflammation extend beyond the lobe primarily attacked, an event occurring at a period more or less remote from the date of the attack, the local phenomena will be reproduced over the lobe or lobes which are successively affected.

Of the signs which enter into the physical diagnosis of pneumonitis advanced to the second stage, excepting the crepitant rale, none are peculiar to this disease. Dulness on percussion, the bronchial respiration, bronchophony, exaggerated vocal resonance, the acute vocal *souffle*, and increased fremitus, may all be found in connection with other affections involving pulmonary solidification. The situation and limitation of the portions of the chest in which the signs are observed, together with the antecedent and concomitant symptoms, suffice for the discrimination of the solidification which arises from lobar pneumonitis. But the circumstances involved in the differential diagnosis will be noticed presently.

The signs by which the progress of the disease from the first to the second stage is ascertained, have been already sufficiently considered. It remains to devote a few remarks to the diagnostic characters which belong to the third or purulent stage. The transition to this stage, in the rare instances in which it occurs, is not, like that of the first to the second stage, signalized by the development of a new series of striking physical phenomena. The signs of solidification continue; and, in fact, there are no criteria by which the occurrence of the third stage may be in all instances positively ascertained. The existence of this stage may be inferred after a protracted duration of the disease, when the evidences of resolution of the disease fail to occur, and the symptoms denote an unfavorable termination, not directly in consequence of the extent to which hæmatosis is compromised (for death thus produced takes place in the second stage), but as the result of asthenia and apnœa combined. A symptom which has a positive bearing on this question, is an abundant puriform expectoration, sometimes taking place rapidly like the discharge from a ruptured abscess, and occasionally emitting a fetid odor. A physical sign possessing considerable significance is the occurrence of abundant moist bronchial rales, at a late period, not preceded by general bronchitis coexisting with the pneumonitis, the dulness on percussion remaining undiminished, the bronchial respiration and voice becoming less marked, these circumstances being taken in connection with symptoms denoting a fatal tendency, viz., prostration, frequency and feebleness of the pulse, delirium, etc.

The formation of abscesses, and their evacuation into the bronchial tubes, leaving cavities, are among the occasional events incidental to the progress of this disease.[1] Do excavations thus formed give rise to distinctive signs, viz., the cavernous respiration and voice, and tympanitic resonance on percussion, with, in some instances, the cracked-metal intonation ? My own observations do not supply facts bearing on this question. Judging from the physical conditions incident to the formation of cavities under these circumstances, and from the testimony of experienced observers, the physical signs occasionally indicating excavations otherwise formed, and which will be noticed more especially in connection with tuberculous disease, are to be deemed possible, but by no means of probable occurrence. On this point Skoda remarks as follows : " I have frequently examined patients suffering from pneumonia, in whose lungs newly formed abscesses were found after death ; but I have never, in any single instance, recognized the presence of abscess by the aid of auscultation or percussion. In every case, the abscess, though communicating with the bronchial tubes, was filled with pus or sanies."[2]

The progress of the resolution of pneumonitis is indicated by diminution of the dulness together with the sense of resistance felt on percussion; decrease of the intensity of the bronchial respiration, which, becoming first broncho-vesicular, gradually assumes the normal characters ; cessation of bronchophony, and the return to the normal vocal resonance ; disappearance of an undue vocal fremitus,—these changes in the physical phenomena associated, of course, and generally succeeding rather than anticipating a marked improvement in the cough, respiration, etc. Facts relating to this point have entered into the consideration of the physical signs furnished by the different methods of exploration in this disease.

Pneumonitis, so far as symptoms are concerned, is sometimes remarkably latent. Expectoration, cough, pain, may all be wanting, and the respiration be but little increased in frequency. The disease fails to present its usual symptomatic phenomena when it is consecutive, much oftener than when primary ; as when it is developed in the course of fevers, purulent infection of the blood, etc. Under these circumstances the diagnosis is to be based almost exclusively on the physical signs. But as regards the latter, the disease may be to a greater or less extent latent; in other words, physical phenomena which are usually present in a marked degree, may be obscure or absent. Thus, not only is the crepitant rale sometimes wanting, but also the bronchial respiration, bronchophony and exaggerated vocal resonance, and fremitus. The solidification which occurs in the latter stage of fevers and other affections, and characterized by the absence of the usual granular deposit (hypostatic pneumonitis), is the form most apt to be deficient in the group of signs just named. Instances in which, together with these signs, all the distinctive symptoms are also wanting, must be exceedingly rare; yet it is not impossible that such a case may be met with. The diagnosis would then rest mainly on the evidence of solidification extending over a lobe, which by means of percussion would still be available. Inasmuch, however, as lobar solidification may take place irrespective of inflammation (from œdema), the existence of pneumonitis notwithstanding this evidence might be questionable. Fortunately a clinical problem so intricate as that just supposed, although within the limits of possibility, is removed far beyond the boundaries of the probable.

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[1] Of 750 cases treated in the great Hospital of Vienna, from 1847 to 1850, pulmonary abscess was observed in but a single instance.

[2] Op. cit. Am. edition, page 311.

The different affections from which pneumonitis is practically to be discriminated, are acute ordinary bronchitis, capillary bronchitis, acute pleuritis, dilatation of the bronchiæ, acute phthisis, and pulmonary œdema. I will consider briefly the more important of the points involved in the differential diagnosis from these affections respectively.

With a proper knowledge and application of physical exploration, pneumonitis need never be confounded with acute ordinary bronchitis; but guided exclusively by symptoms, the discrimination is not always easy, and in some cases it is impracticable. Moreover, the two affections may be conjoined, and under these circumstances the question whether the bronchitis be complicated with pneumonitis, or not, is to be settled mainly by the physical signs. Simple bronchitis and simple pneumonitis present a striking contrast in several prominent symptoms. The pain in pneumonitis is sharp, lancinating, and generally referred to the vicinity of the nipple. In bronchitis, if pain be present, it is dull, contusive, and situated beneath the sternum. The expectoration in bronchitis rarely contains blood, and, when present, it is in the form of bloody points or streaks. In pneumonitis bloody expectoration is common, and the blood is intimately mixed with viscid mucus, giving rise to the characteristic rusty sputa. The febrile movement in cases of acute pneumonitis is generally intense, while in ordinary bronchitis, however acute, it is only moderate. More or less acceleration of the breathing generally characterizes cases of pneumonitis, and occurs only occasionally in ordinary bronchitis.

But the physical phenomena are more distinctive. The crepitant rale is wanting in bronchitis, nor in the ordinary form of that affection is there any rale approximating to the crepitant sufficiently to occasion any liability to error. The sonorous, sibilant, and mucous rales may be present more or less combined, and these rales are rarely prominent in cases of pneumonitis, except it be associated with general bronchitis. When observed in cases of pneumonitis not associated with general bronchitis, they are limited to one side of the chest, save in the very rare instances of double pneumonitis; but in bronchitis they are found on both sides. The chest in cases of bronchitis everywhere preserves its normal sonorousness on percussion, which, indeed, may be abnormally increased. In pneumonitis, on the other hand, soon after the access of the disease, marked dulness, with increased sense of resistance, is found to exist over a space corresponding in size and situation to one of the pulmonary lobes. Bronchophony, exaggerated vocal resonance and fremitus, and the acute bronchial *souffle*, with whispered words, belong to the history of pneumonitis, and are never produced as effects of bronchitis.

Between pneumonitis and capillary bronchitis there are more points of similitude; nevertheless, the points of dissimilitude are amply sufficient for the differential diagnosis. Capillary bronchitis is accompanied by greater embarrassment of respiration and suffering from defective hæmatosis, than obtain in pneumonitis. The acceleration of the pulse is greater. The rusty sputa are wanting; blood, if present, existing in streaks. Reliance, however, must be placed chiefly on the physical signs. The percussion-resonance in capillary bronchitis generally remains unaffected, and may be abnormally increased. If dulness occur, it arises from collapsed lobules, and is not found to extend over a space corresponding to an entire lobe. Auscultation discloses a sub-crepitant rale, succeeding or coexisting with the sibilant rale, and existing on both sides of the chest over the posterior surface. The existence of this rale on the two sides is a fact eminently distinctive, but aside from this fact, the intrinsic differences between the sub-crepitant and the true crepitant rales, which have been fully pointed out, suffice for their discrimination from each other. Finally, in capillary, as in ordinary acute bronchitis, bronchial respiration, bronchophony, increased vocal resonance, and the acute bronchial *souffle* with whispered words, are wanting.

The diagnostic features of acute pleurisy are to be considered hereafter. It suffices for the present object to state that the more important of these features arise from the accumulation of a considerable quantity of liquid effusion within the pleural sac. The physical signs denoting the presence of fluid in the chest, together with the absence of the crepitant rale and the phenomena denoting a marked degree of pulmonary solidification, establish the differential diagnosis. Moreover, in pleurisy the febrile movement is less intense than in acute pneumonitis; cough and expectoration are frequently slight or altogether absent; the rusty sputa are wanting, and the matter of the expectoration, unless bronchitis be associated, is unaltered mucus. It is not very uncommon for practitioners possessing an imperfect knowledge of the principles and practice of physical exploration, to mistake pneumonitis for pleurisy, and *vice versa.* Due acquaintance with the circumstances involved in distinguishing pulmonary solidification from liquid effusion, will obviate the liability to this error. The points of distinction between these two morbid conditions have been already considered, and will be recapitulated in connection with the subject of pleurisy.

Dilatation of the bronchia, in connection with an attack of acute bronchitis, gives rise to certain of the physical signs present in pneumonitis, viz., bronchial respiration and bronchophony or exaggerated vocal resonance, together with dulness on percussion. The symptoms incident to the acute bronchitis, associated with the physical phenomena pertaining to the bronchial dilatation, if the practitioner be not aware of the previous existence of this lesion, might lead to the suspicion of pneumonitis advanced to the stage of solidification. An investigation of the history and present phenomena, in such a case, will show that chronic cough and expectoration have existed for a greater or less period prior to the attack; and that the signs suggesting pneumonic solidification are not, as in lobar pneumonitis, either bounded by a line coincident with the interlobar fissure, or extending over the entire lung on one side. In the progress of the case, after the symptoms of the acute bronchial inflammation are relieved, percussion and auscultation show the physical phenomena still persisting, owing to the permanency of the lesion. Dilatation of the bronchiæ is an affection of such rare occurrence, that it falls to the lot of but few physicians to be called to discriminate between it and other affections.

Cases of rapid and extensive tuberculosis may present a group of symptoms and signs, which, without due attention, may for a time deceive the practitioner. Dulness on percussion, the bronchial respiration, bronchophony or exaggerated vocal resonance, and fremitus, with the sub-crepitant, and possibly a crepitant rale, may coexist with accelerated breathing, frequent pulse, cough and expectoration, lancinating pains, these symptoms having been so rapidly developed as not to suggest at once the idea of tuberculosis. Careful and continued investigation, however, will lead to the discovery of certain of the positive features of phthisis, and at the same time authorize the exclusion of pneumonitis by the absence of some of its distinctive traits. In the vast majority of cases of phthisis, the deposit occurs first near the apex of the lungs. The physical signs will, therefore, be found at the summit of the chest. Pneumonitis attacks the upper lobe primarily in but a small proportion of cases, and hence, the situation of the physical phenomena in itself should excite suspicion of tubercle. A tuberculous deposit rarely extends within a brief period over an entire lobe, so that the signs will be likely to be limited to a space more or less circumscribed below the clavicle, when, if the affection were simple pneumonitis, the entire lobe would be soon invaded, and its boundary line determined by means of percussion and auscultation to be in the situation of the interlobar fissure. Hemorrhage will be likely to occur in connection with tuberculous disease, and not in pneumonitis, except in so far as it enters into the production of the rusty sputa. The lancinating pains in phthisis are generally referred to the summit of the chest, or are seated beneath the scapula, not fixed in a point at or near the nipple, as in pneumonitis. The characters of the pulse in "tuberculous fever" differ from those which belong to the febrile movement symptomatic of an acute local inflammation. In the former the pulse is often very frequent, vibratory or thrilling, denoting irritability rather than increased force in the ventricular contraction. In the latter it is less rapid, but stronger, indicating abnormal power in the action of the heart. Rapid loss of weight characterizes acute phthisis. Diarrhœa frequently occurs. The patient, notwithstanding the greater frequency of the pulse, and with an equal, if not greater disturbance of the respiration than ordinarily attends pneumonitis, does not yield to the disease and take to the bed, as when attacked with pneumonic inflammation. Acute phthisis, when it is most rapidly developed, does not present the abrupt access which generally characterizes cases of pneumonitis.

The differential diagnosis may be more difficult when the tuberculous deposit, in deviation from the laws of the disease, takes place first at the base of the lung, and gradually extends upward. This anomalous form of tuberculous development, according to the observations of Dr. H. I. Bowditch, occurs in a ratio of 1 to from 150 or 200 cases.[1] The greater liability to error of diagnosis in this variety of phthisis arises from the physical signs being manifested in the same situation as in most cases of pneumonitis, viz., on the posterior surface of the chest, especially below the scapula, and also from the presence of the crepitant rale, which was observed in seven of eight cases reported by Dr. Bowditch. The combination of physical signs, in fact, may be precisely that which characterizes pneumonitis. The incongruousness of the associated symptoms, on the supposition that pnumonitis exists, and the presence of certain of the traits significant of phthisis, point to the nature of the disease. With the physical signs just mentioned, patients preserve strength sufficient to be up and out of doors. The disease even if rapidly developed is always more gradual than pneumonitis. Hemorrhage occurs in a certain proportion of cases. The ragged opaque sputa of phthisis are sometimes observed. Acute symptoms are by no means uniformly present in this variety of tuberculous disease. The crepitant rale is persistent, continuing for weeks and even months. Although, therefore, the combination of physical signs and their situation are the same as in pneumonitis, the associated circumstances and the progress of the disease present points of disparity which speedily lead to the correction of an error in diagnosis, liable to arise from inadvertency or a premature conclusion.

Œdema of the lungs extending over one or more lobes may give rise, to some extent, to the physical signs incident to the stage of solidification from pneumonitis. Over œdematous lung there will be dulness on percussion, with, possibly, bronchial respiration, bronchophony or exaggerated vocal resonance, and fremitus. These auscultatory phenomena, however, are rarely marked, and often absent. A well-marked crepitant rale is sometimes observed, but the sub-crepitant is much oftener present. Œdema occurring always as a secondary affection, from hypostatic congestion in fevers, from a changed condition of the blood leading at the same time to serous infiltration in other parts, from the obstruction proceeding from disease of heart, etc., its existence may be presumed when the physical signs denoting solidification become developed in those pathological connections, without being preceded or accompanied by the symptoms of acute pneumonitis. Moreover, the causes producing the œdema acting equally on both lungs, the local evidences of the solidification in a certain proportion of cases, although not generally, are found on each side of the chest.

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[1] Cases of anomalous development of tubercles, etc., by Henry I. Bowditch. American Medical Monthly, N. Y. 1855.

An œdematous condition may occur as a sequel of pneumonitis in the portion of lung which has been the seat of the inflammation.

SUMMARY OF THE PHYSICAL SIGNS BELONGING TO ACUTE LOBAR PNEUMONITIS.

The vesicular percussion-resonance diminished during the stage of engorgement, but in a more marked degree after solidification has taken place; sense of resistance notably increased; the limits of the dulness and loss of elasticity corresponding to the boundaries of the affected lobe; the vesicular resonance often replaced by a tympanitic sonorousness, more or less marked; the crepitant rale generally discovered by auscultation, accompanied or followed by the broncho-vesicular and the bronchial respiration; bronchophony and exaggerated vocal resonance generally present; increased vocal fremitus over the solidified lung existing in a large proportion of cases, occasionally pectoriloquy; an acute *souffle*, frequently intense, accompanying whispered words; sub-crepitant rale during the resolution of the disease in some instances; the moist and dry bronchial rales occasionally heard, but rarely prominent unless the disease advance to the stage of purulent infiltration, when the moist rales may be more or less abundant; a friction-sound heard in a small proportion of instances; on the unaffected side exaggerated respiration; diminished respiratory movements on the affected side sometimes apparent on inspection, if the affection be limited to a single lobe; oftener observed, and in a more marked degree, if the inflammation extend over an entire lung; contraction of the side affected after resolution in some cases.

LOBULAR PNEUMONITIS.

LOBULAR PNEUMONITIS; *Broncho-Pneumonia; Imperfect Expansion (atelectasis) and Collapse of Pulmonary Lobules.*—The term lobular when properly applied to cases of pneumonitis, implies that the inflammation, instead of extending over an entire lobe, is more circumscribed, being confined to lobules, either isolated or in clusters, situated at different points, more or less numerous, and disseminated usually over the pulmonary organs, on both sides of the chest. It is only within a few years that the attention of pathologists has been directed to the study of such a form of the disease. It was first fully described as a distinct variety of pneumonitis, occurring in children under six years of age, in this country by Dr. Gerhard,[1] and in France by Dr. Rufz,[2] Rilliet and Barthez,[3] Valleix,[4] and others. As described by the writers just mentioned, lobular pneumonitis embraces all cases in which, after death, the lungs are found to present solidified portions (exclusive of solidifications from tubercle or other heteromorphous deposits), varying in size from a pea to a filbert, scattered irregularly, occasionally confined to one side, but much oftener distributed over both lungs, varying in number from 2 to 30; the intervening parenchyma preserving the characters of the normal spongy tissue. This pathological condition in a large majority of instances is associated with the anatomical characters of bronchitis, and hence the affection is often called *broncho-pneumonia*, a term first applied, in 1837, by a German author, Seifert.

Researches still more recent have shed new light on the morbid anatomy and the pathology of affections heretofore, and still to a greater or less extent, included under the appellation of lobular pneumonitis and broncho-pneumonia. In 1832, Prof. Jörg, of Leipsic, published an account of a morbid condition found in the bodies of newly born children, analogous to that regarded as characteristic of lobular pneumonitis, which he attributed to imperfect expansion of the lungs by the first inspirations after birth; in other words, more or less of the lobules remaining in the fœtal state. To this morbid condition he applied the title of *atelectasis*. This condition had been previously described by a French writer, M. Dugés, in 1821, in a thesis which failed to attract attention to the subject. The anatomical characters regarded as distinctive of a persisting fœtal condition, are as follows:—the solidified lobules giving rise to depressions on the surface of the lung; the pleural covering retaining its glistening polished aspect; the size of the lobules affected, and the lobe in which they are found not augmented, but diminished; the cut surfaces, when the solidified lobules are incised, wanting a granular appearance, smooth like muscle, and the tissue not softened or friable as it is in the second stage of ordinary pneumonitis. The morbid appearances, in other words, are those which belong to the condition called *carnification*. An important point of evidence, according to Jörg, of the morbid condition called by him atelectasis, was, that by insufflation the condensed lobules were found to be capable of being brought to a normal condition.[1]

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[1] Am. Jour. of Med. Sciences, 1834. [2] Journ. des Conn. Médico-chirurg. 1835.
[3] Traité des Maladies des Enfans. [4] Traité des Maladies des Enfans nouv. nés, 1833.

Still more recently, the researches of MM. Legendre and Bailly, of Paris, demonstrated that, in a certain proportion of the cases of so-called lobular pneumonitis, in which the affection is developed at a period more or less removed from birth, the affected lobules are in a condition analogous to that of fœtal life: that is to say, the characters pertaining to the condensation are those of carnification as distinguished from red hepatization, and the fact that the air vesicles are not occluded by a solid deposit, as in cases of ordinary lobar pneumonitis, is shown by the solidification being removed by insufflation. The authors just named first suggested this simple test of the condensation occasioned by morbid causes acting after birth, being due to a return to the fœtal state, although the same means had been previously resorted to by Jörg in cases of supposed atelectasis.[2]

The distinctive appearances of the parts in the one case preserving, and in the other case resuming a fœtal state, had by no means escaped the notice of earlier writers on the subject of lobular pneumonitis. They had, however, attributed the production of this morbid condition to inflammation, attributing the differences in the anatomical characters—absence of the granular deposit, want of friability, etc., to modifications of the inflammatory processes peculiar to early life. The investigations of Jörg, and Legendre and Bailly, tend to the conclusion that the cases of so-called lobular pneumonitis, in which the lobules are in the fœtal state, or carnified, be sought for with care, and by patience it may sometimes be heard at the end of an unusually deep inspiration, such as occurs in connection with a fit of coughing, when in ordinary breathing it is not appreciable. It may be developed during a short interval separating successive examinations, owing to inflammation having in the meantime extended to new portions situated nearer the surface of the lung. It may be observed or drowned by the bronchial rales incident to antecedent and coexisting bronchitis.

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[1] The cases given by Valleix and others of lobular pneumonitis in still or newly born children, supposed to have existed in intra-uterine life, were probably cases of atelectasis.

[2] Archives Générales de Médecine, 1848.

Dulness on percussion may not be apparent while the inflamed portions are but few in number, small and centrally situated. When, however, the solidification has extended over a certain space, the percussion-resonance is obviously impaired. The advantage of contrasting the two sides is oftener available in cases of solidification from inflammation, than from collapse, because in the former instance it is more likely to be limited to one lung. An increased sense of resistance on percussion, will serve to confirm the fact of relative dulness on one side.

The broncho-vesicular and a well-marked bronchial respiration oftener accompany lobular pneumonitis than condensation from collapse, owing to the greater force of the respiratory movements in the former affection. The same remark is equally applicable to exaggerated vocal resonance and fremitus, manifested in connection with the cry of the patient.

For a similar reason the existence of supplementary respiration in healthy portions of lung, will be likely to distinguish this form of disease from collapse. A greater activity of the respiratory movements will also be apparent on inspection.

The points pertaining to physical signs just mentioned, in addition to those belonging to the history and symptoms, will assist in the discrimination of lobular pneumonitis from collapse.

Lobular pneumonitis is to be clinically discriminated from other affections. In cases of ordinary acute bronchitis, the question will sometimes arise, whether the affection be bronchitis simply, or broncho-pneumonia. The former, as has been seen, often merges into the latter. The circumstances indicating an extension of the inflammation to the parenchyma are, acceleration of the breathing, with dilatation of the alæ nasi; circumscribed flush of the cheeks; increased febrile movement. To these symptoms may be added, the crepitant rale in some instances, this, of course, rendering the diagnosis as complete as possible. Exclusive of this sign, if dulness on percussion be well-marked, the diagnosis lies between pneumonitis and collapse; and the associated signs and symptoms, taken in connection with the history, will frequently, if not generally, enable the practitioner to arrive at a decision.

The discrimination is also to be made between lobular pneumonitis and capillary bronchitis. The latter is a much graver form of disease. The respirations are more hurried; the dyspnœa more intense; the evidences of imperfect hæmatosis greater; the circulation more disturbed. Percussion, if the affection have not induced collapse of more or less of the pulmonary lobules, elicits everywhere over the chest a clear resonance; and, at all events, solidification, if it exist, is insufficient in extent to account for the extreme disorder of the respiration and the circulation. The crepitant rale is wanting; but the sub-crepitant is extensively diffused over both sides of the chest. Due attention to these points will render the differential diagnosis, in general, not difficult.

Some cases of acute phthisis in young children, may present characters derived both from symptoms and signs, causing it to simulate lobular pneumonitis. It is well known that in children the tuberculous deposit takes place frequently with great rapidity, and, as regards situation, does not obey the law, in accordance with which, in adults, the superior portion of the upper lobe is first affected in the vast majority of cases. So also the law which determines the seat of pneumonitis in the inferior lobe with rare exceptions, does not apply to the same extent to the child. These deviations impair the facility of diagnosis. The physical signs attendant on solidification from tubercle are essentially the same as in consolidation from inflammation. Bronchitis and febrile movement may accompany both affections. Moreover, the two affections may be combined, constituting what pathologists have called tuberculous pneumonia. The circumstances attending the development of the disease, and its progress, which belong to the history of phthisis, and the prior condition of the patient as regards a constitutional tendency to that disease, together with the positive indications of a tuberculous diathesis, in cases of doubt, must be relied upon in making the discrimination. These points cannot be here considered without anticipating subjects belonging to another chapter.

Lobular pneumonitis is not unfrequently overlooked, the patient being supposed to labor under some other affection. Thus the occurrence of convulsions, and drowsiness, sometimes lead the practitioner to refer the chief malady to the head. Vomiting and diarrhœa, events of occasional occurrence, may cause the attention to be concentrated on the alimentary canal. The disease may be mistaken for infantile fever. These errors of diagnosis are chargeable on a want either of proper knowledge or attention. The discrimination does not involve sufficient real difficulty to require that the differential diagnosis should be formally considered.

CHRONIC PNEUMONITIS.

Following the example of writers generally, who have treated of diseases affecting the respiratory organs, I shall dispose of the subject of chronic pneumonitis in a summary manner. Our knowledge of this form of disease is imperfect. Laennec questioned its existence. Nearly all pathological observers are agreed, as respects the infrequency of its occurrence, and different opinions on this point may be in a great measure accounted for by difference of views as to the morbid conditions to which the name of chronic pneumonitis is properly applied. Some writers (Andral, Hasse), who regard it as not very uncommon, embrace under this title certain cases of tuberculosis characterized by solidification of the pulmonary parenchyma between the tuberculous deposits. Under these circumstances the morbid condition, admitting it to be chronic pneumonitis, is incidental to tuberculosis, and it is not, therefore, to be considered a separate form of disease. It is probable that cases of collapse have been sometimes set down as instances of chronic pneumonitis. For example, a case reported by M. Requin, and detailed by Grisolle,[1] in which the lower lobe of the right lung was found after death firmly condensed, non-granular, without tubercles or miliary granulations, may be suspected to have been of that description. The same remark will apply to cases of carnification supposed to result from chronic inflammation of the pulmonary parenchyma. An instance of this kind is quoted by Grisolle, from MM. Rilliet and Barthez.

According to Rokitansky, the morbid condition characteristic of chronic pneumonitis consists in the presence of inflammatory exudation within the areolar tissue uniting the pulmonary lobules, and the smaller groups of air-cells, and he applies to this form of disease the title of *interstitial pneumonia.* This infiltration within the interstitial tissue, he states, in the progress of time becomes organized and coalesces with the latter, so as to form a dense cellulo-fibrous substance, which compresses and obliterates the air-cells, leading to contraction of the thorax and dilatation of the bronchial tubes. This is essentially the form of disease described by Corrigan, and designated by him cirrhosis of the lung, to which reference has been made in connection with the diagnosis of dilatation of the bronchiæ.

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[1] Traité Pratique de la Pneumonie, p. 351. This case is referred to by Dr. Walshe, under the head of Chronic Pneumonia.

As a sequel of acute inflammation, chronic pneumonitis is exceedingly rare. Grisolle in his treatise giving the results of the analysis of 373 cases of pneumonitis, states that he has met with but a single instance in which the acute terminated in a chronic form of the disease. M. Barth found but a single instance in a collection of 125 cases of acute pneumonitis.[1] It is true that frequently after acute inflammation the physical evidences of solidification continue for some time, not disappearing entirely for weeks or even months. It would, however, be incorrect to say that under these circumstances the disease was perpetuated in a chronic form. In cases of veritable chronic pneumonitis succeeding the acute disease, the acute symptoms disappear, but more or less febrile movement continues, occurring in paroxysms, or with marked exacerbations. Cough and expectoration persist, the latter not preserving the characters significant of the acute disease; the respiration is accelerated, with dyspnœa; the appetite does not return, or if it returns speedily fails; the patient loses strength and weight, and, at length dies, after the lapse of two or three months. The physical signs of solidification persist during the progress of the chronic disease, viz., notable dulness on percussion, with bronchial respiration, increased vocal resonance, and fremitus, etc. In the case reported by M. Requin, above mentioned, the auscultatory phenomena denoting solidification, viz., bronchial respiration and exaggerated vocal resonance, were wanting. This occasionally happens in acute pneumonitis. Whether it is more likely to occur in the chronic form of the disease, it is impossible to say, in view of the very limited number of cases of the latter which have been reported.

It is evident from the foregoing brief account of chronic pneumonitis that except so far as it is involved in a lesion already considered, viz., dilatation of the bronchiæ, it is an affection possessing comparatively small interest and importance in a practical point of view.

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[1] Valleix, op. cit.

Although the physician is very rarely called upon to make the diagnosis, the fact of its occasional occurrence is not to be lost sight of. In cases in which, after acute pneumonitis, physical signs denoting solidification are found to remain, associated with symptoms which indicate a grave malady, viz., febrile exacerbations, loss of strength and weight, cough and expectoration, etc., the question may arise whether the patient be affected with chronic pneumonitis or tuberculosis. If the physical signs denote solidification of the upper lobe, and especially if they denote that the solidification is confined to the upper portion of the lobe, the chances against the existence of tubercle are exceedingly small. The chances are greatly increased if the local affection be seated in the lower lobe; but this situation is not conclusive evidence against the existence of tubercle, for, as exceptions to the general law, the tuberculous deposit in some instances takes place first in the lower lobe. The differential diagnosis rests mainly on the presence or absence of the events characteristic of the progress of tuberculous disease, viz., hæmoptysis, pleuritic pains, nocturnal sweats, etc., together with the physical evidences of the local changes incident to phthisis, viz., softening of the tuberculous matter and the formation of cavities.

CHAPTER IV.

EMPHYSEMA.

THE term emphysema is used to designate two quite different pulmonary affections. In one of these affections the morbid condition consists in an abnormal increase in size of the air-cells, and consequent over-accumulation of air within them. This is by far the more frequent in occurrence of the two affections, and is generally understood when the word emphysema is applied without any qualification to a morbid condition of the lungs. The term is manifestly inappropriate, since there is only a remote analogy of the pulmonary affection, to the extravasation of air into areolar structure, the latter being the morbid condition designated by emphysema when it is used without special reference to the pulmonary organs. *Dilatation of the air-cells*, and *rarefaction of the lung*, are titles more expressive of the morbid condition, and are to be preferred. *Vesicular emphysema* and *true pulmonary emphysema*, are expressions employed by Laennec and subsequent writers to distinguish the affection now referred to.

The other affection to which the name of emphysema is applied, consists in the extravasation of air into the areolar structure uniting together the pulmonary lobules, and connecting the pleura with the superficies of the lung. This morbid condition, more correctly than the first styled emphysematous, is distinguished as *interlobular and sub-pleural emphysema.*

These two forms of the disease claim separate consideration; but the latter will require comparatively brief space.

I. VESICULAR EMPHYSEMA.

VESICULAR EMPHYSEMA; *Dilatation of the Air-cells; Rarefaction of Lung.*—Laennec was the first to give a clear description of this affection; and in view of the originality and value of his researches, a distinguished morbid anatomist of the present day,[1] has said that "had Laennec done nothing else for medical science, his discovery of this diseased condition, and of the causes giving rise to it, would have sufficed to render his name immortal." The pathological relations of dilatation of the air-cells, and the mode in which the lesion is produced, are subjects of great interest and importance, which at the present moment are under discussion, and concerning which conflicting opinions are maintained by different writers. Conformity to the plan of this work renders it necessary to forego any consideration of these subjects, limiting the attention to the physical signs and the diagnosis of the affection.[2]

Physical Signs.—Dilatation of the air-cells is accompanied by physical signs which, combined, are quite distinctive of the affection.

Percussion elicits, with few exceptions, an exaggerated sonorousness. The resonance is deficient in vesicular quality. The pitch is raised. The sound, in other words, without becoming purely tympanitic, acquires more or less of the tympanitic character; it is vesiculo-tympanitic. This abnormal modification is more marked, of course, when the emphysema is limited to one side, being contrasted with the normal resonance on the unaffected side. The emphysema, however, when it exists on both sides, being usually greater on one side than on the other, a disparity between the two sides is apparent. Under these circumstances, the vesiculo-tympanitic character of the sound is generally obvious on both sides, but this character is more strongly marked on the side which, at the same time, presents other signs significant of a greater amount of dilatation of the air-cells. Occasional exceptions to the rule of exaggerated resonance are observed. In a single instance, the emphysema existing on both sides, but greater on the right side, I have noted that the sonorousness on the left side exceeded that on the right, the resonance being less vesicular and higher in pitch on the right side. It is to be borne in mind, that a natural disparity as respects the points just named exists in many persons.

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[1] Rokitansky.

[2] The author cannot forbear referring the reader to the late views respecting the pathological relations and the production of dilatation of the cells, which have been advanced by Dr. W. T. Gairdner of Edinburgh. These views are certainly highly interesting and ingenious, if they are not destined to effect a radical change in the opinions commonly held on these subjects. Vide Brit. and For. Med. Chir. Review, April, 1853; or a treatise entitled "On the Pathological Anatomy of Bronchitis, and the Diseases of the Lung connected with Bronchial Obstruction." Edinburgh, 1850.

The sense of resistance is increased over emphysematous lung in proportion to its increase of volume. In cases in which the chest is partially or generally enlarged, this sign, incidental to the act of percussion, is present in a marked degree.

An unnatural clearness of resonance is found in the præcordia, especially if the left lung be affected. The heart may be removed from contact with the walls of the chest, and carried downward, so that between the sternum and nipple, the chest becomes highly resonant. If the emphysema be general, or affect the lower lobes, the pulmonary resonance extends below its normal limits, toward the base of the chest. For example, on the right side, in front, the line of hepatic flatness may be depressed to the ninth or tenth ribs on a vertical line through the nipple; and, owing to the permanent expansion of the lung, this line is found to vary but little with the successive acts of inspiration and expiration, even when they are voluntarily increased. A similar extension of the space occupied by pulmonary resonance, is apparent on the lateral and posterior surfaces of the chest at the base, and also at the summit, in some instances, above the clavicle, and at the upper part of the sternum, where, from its relation to the trachea, the normal resonance is tubular. In cases in which the emphysema is confined to one side, if the volume of the lung be considerably augmented, the exaggerated vesiculo-tympanitic resonance extends beyond the median line on the opposite side, in consequence of the lung exceeding laterally its normal limits and encroaching on the space belonging to its fellow.

The auscultatory phenomena due to the emphysema are to be distinguished from those attributable to bronchial inflammation or catarrh which so frequently coexist. Exclusive of those to which these complications give rise, the signs pertaining to the respiration are, in themselves, highly characteristic of the affection, and in combination with the evidence derived from percussion, their diagnostic significance is quite positive. Feebleness of the respiratory murmur is one of the distinctive features. In some instances a respiratory sound is inappreciable with the ordinary stethoscope or by immediate auscultation, and is scarcely heard with Cammann's instrument. Other things being equal, the feebleness is proportioned to the degree of the emphysematous condition. When both lungs are affected, but one lung more than the other, a disparity will be found to exist between the two sides in this particular; and the greater feebleness of respiratory sound, is on the side presenting the greater clearness and tympanitic quality of percussion-resonance. The respiratory murmur may be almost or quite null on this side, and the intensity relatively greater on the other, but more or less below the normal amount. On the other hand, if the emphysema be limited to one lung, the respiratory sound emanating from the other lung will be likely to exceed the normal intensity, in other words, be supplementarily exaggerated. An exaggerated respiration may also exist on the affected side or sides, over the portions of lung to which the emphysema does not extend. When the emphysema is confined to the upper lobe, the respiratory murmur below the scapula, behind, will be found to be in a marked degree more intense than at the summit in front, the reverse being the case in health.

The respiratory sound is altered in other respects than intensity. It is changed in rhythm. The inspiration is shortened. The inspiratory sound is deferred; that is, more or less of the inspiratory act takes place before the sound is appreciable. Sometimes a very brief sound only is heard at the close of the act. The expiratory sound, on the other hand, is often prolonged, frequently exceeding considerably in duration the sound of inspiration. The expiratory sound is always more or less feeble; but its intensity may be greater than that of the sound of inspiration. The latter may be almost inappreciable while the former is distinctly although faintly heard.

The respiratory sound also undergoes a change in quality. It is said to become *rough*. The inspiratory sound has less of the vesicular quality than belongs to the normal murmur, and is raised in pitch. So far it presents the characters of that abnormal modification generally distinguished as *roughness*. It differs, however, materially from the broncho-vesicular respiration incident to a morbid condition, the opposite of rarefaction, viz., increased density of the pulmonary structure. The prolonged expiration, if it be a pure respiratory sound without an admixture of a sibilant rale, is lower in pitch than the sound of inspiration, while in a broncho-vesicular respiration due to condensation, the pitch of the prolonged expiratory sound is higher than that of the sound of inspiration. In emphysema the expiratory is generally continuous with the inspiratory sound. In condensation of lung a brief interval separates the two sounds. The shortened inspiration in emphysema is *deferred;* in condensation it is *unfinished.*

In the majority of instances, at the time the affection comes under the observation of the physician, it is associated with bronchitis, or catarrh, and frequently with bronchial spasm constituting an attack of asthma. Under these circumstances physical signs are present, due to the coexisting affections, but more or less modified by the emphysema. The moist bronchial rales are observed in a certain proportion of cases, consisting of the fine mucous or the sub-crepitant varieties, if the inflammation extend to the smaller tubes. Much oftener the dry rales are present—the sonorous or sibilant. The latter is heard more frequently than the former, but both are not unfrequently combined. In asthmatic paroxysms these rales are loud and diffused, accompanied by wheezing, which may be heard at a considerable distance from the patient. Exclusive of asthma, they denote either bronchial inflammation or irritation superadded to the emphysema. The rales often take the place of the respiratory sound, *i. e.* nothing else is heard. They are generally more marked in expiration than in inspiration; and the sibilant are oftener heard than the sonorous, exclusive of the complication of asthma.

Auscultation of the voice furnishes negative, or at least doubtful, results in cases of emphysema. Judging from my own observations, I would say that the vocal resonance does not, in general, undergo either marked increase or diminution in this affection. It is certain that if it be materially modified, the modifications are occasional, not constant. I have observed the naturally greater vocal resonance of the right side to be preserved when the emphysema was limited to the left side (as determined by other signs), and, on the other hand, I have observed the same natural disparity when the greater amount of emphysema was on the right side. Walshe states that intense bronchophony may exist over lung greatly rarefied. I cannot but suspect in such instances that it is due to a normal peculiarity, existing irrespective of the emphysema.

Auscultation in the præcordial region, with reference to the pulmonary and cardiac sounds, affords a means, in addition to percussion and palpation, of determining whether the heart is abnormally overlapped by lung, or displaced from its normal situation. The presence of a layer of lung between the organ and the thoracic walls may be shown by a feeble respiratory murmur, or the bronchial rales diffused over the whole of the præcordia. The heart-sounds, under these circumstances, are faint and distant. They may be inappreciable in the præcordia, but if the displacement be downward toward the epigastrium, they may be heard with distinctness in the latter situation.

Inspection furnishes striking corroborative evidence of the existence of emphysema. The frequency of respiration is often abnormal.

a distinguished morbid anatomist of the present day,[1] has said "had Laennec done nothing else for medical science, his discovery this diseased condition, and of the causes giving rise to it, would have sufficed to render his name immortal." The pathological relation of dilatation of the air-cells, and the mode in which the lesion is produced, are subjects of great interest and importance, which at present moment are under discussion, and concerning which conflicting opinions are maintained by different writers. Conformity to plan of this work renders it necessary to forego any consideration these subjects, limiting the attention to the physical signs and diagnosis of the affection.[2]

Physical Signs.—Dilatation of the air-cells is accompanied physical signs which, combined, are quite distinctive of the affection.

Percussion elicits, with few exceptions, an exaggerated sonorousness. The resonance is deficient in vesicular quality. The pitch raised. The sound, in other words, without becoming purely tympanitic, acquires more or less of the tympanitic character; it is vesiculo-tympanitic. This abnormal modification is more marked, of course when the emphysema is limited to one side, being contrasted the normal resonance on the unaffected side. The emphysema, however, when it exists on both sides, being usually greater on one than on the other, a disparity between the two sides is apparent. Under these circumstances, the vesiculo-tympanitic character of sound is generally obvious on both sides, but this character is strongly marked on the side which, at the same time, presents signs significant of a greater amount of dilatation of the air-cells. Occasional exceptions to the rule of exaggerated resonance are served. In a single instance, the emphysema existing on both sides but greater on the right side, I have noted that the sonorousness the left side exceeded that on the right, the resonance being vesicular and higher in pitch on the right side. It is to be borne mind, that a natural disparity as respects the points just named in many persons.

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[1] Rokitansky.

[2] The author cannot forbear referring the reader to the late views respecting pathological relations and the production of dilatation of the cells, which have advanced by Dr. W. T. Gairdner of Edinburgh. These views are certainly highly resting and ingenious, if they are not destined to effect a radical change in the commonly held on these subjects. Vide Brit. and For. Med. Chir. Review, April or a treatise entitled "On the Pathological Anatomy of Bronchitis, and the Diseases the Lung connected with Bronchial Obstruction." Edinburgh, 1850.

clavicle and a point at or a little below the nipple, the degree of enlargement approaching to that of full inspiration is not uncommon. This abnormal fulness will, of course, be confined to one side, if the emphysema be thus limited. In cases in which both the lungs are affected, the abnormal prominence will generally be greater on one side than on the other, owing to the fact that the two lungs are rarely equally affected; and as observations appear to show that the left lung is oftener more augmented in volume than the right, it will be oftener observed on the left side. In comparing the two sides with reference to this point, it is to be borne in mind, that normally a disparity exists in the anterior portion of the chest in many persons. According to the observations of M. Woillez, the left side presents a projection obviously greater than the right, above a point at or a little below the nipple, in about 26 per cent. of persons free from disease or deformity. It is not improbable that, owing to this natural disparity having been overlooked, a greater relative fulness of the summit of the left side may in some instances have been incorrectly attributed to a larger amount of emphysema on that side. A test of the prominence here or elsewhere, being due to the pressure of rarefied lung, is afforded by the results of percussion and auscultation.

In some cases of emphysema the expanded lung effaces the depression existing above the clavicle, causing a bulging in this situation. This, when present, is highly characteristic, but it is rarely observed.

The inferior portion of the chest may appear to be considerably contracted. This is in part apparent in consequence of the enlargement of the superior portion, but it is, also, in some cases to a greater or less extent real; the dimensions of the chest at its lower part are actually lessened. On the other hand, the upper part of the abdomen may acquire an unnatural fulness, and resistance to pressure, owing to the flattening of the diaphragm, which presses downward and outward, the organs lying below it.

A close examination of the expanded portion of the chest shows the same relations of its different parts which obtain in health after a full inspiration, viz., the obliquity of the ribs is diminished; the ribs and costal cartilages are nearly on one line; the shoulders are raised; the intercostal spaces are narrowed at the summit, and widened over the middle of the chest.

Patients who have suffered long from emphysema, generally present spinal curvature more or less marked. The dorsal curve is increased; the lower angles of the scapulæ project, and, hence, a stooping gait is somewhat characteristic. These changes are sometimes highly marked.

The condition of the intercostal spaces in parts of the chest enlarged by the distension of emphysematous lung, has been a mooted point. According to Dr. Stokes, the effect is never to efface the depression between the ribs. Observation, however, appears to have established, what would rationally be expected, that at the summit of the chest the intercostal muscles yield to the pressure of the lung more readily than the ribs, and hence, that the depressions in persons in whom they are visible in this situation in health, become diminished, if not effaced. That this is rarely observed at the lower part of the chest in front and laterally, where the depressions are most conspicuous, is true. One reason for this is, that the emphysema is generally limited to or is much greater at the upper portion of the lungs. Another reason is, that traction of the diaphragm renders the depressions deeply marked during inspiration, notwithstanding the increase of the volume of the lung. In a case of emphysema limited to one side, not attended by dyspnœa, or labored respiration, I have observed the antero-lateral intercostal depressions at the lower part of that side abolished, presenting, in this particular, an appearance very similar to that caused by the distension of the chest by liquid in the pleural sac, and, in fact, prior to the case coming under my observation, the patient was supposed to be affected with chronic pleurisy.

Characteristics relating to the movements of the chest are not less striking than those incident to alterations in size and configuration. When the augmented volume of the lung is sufficient to keep the chest permanently dilated at a point not much below the limits of a full inspiration, of course the range of expansive movement in respiration is correspondingly restrained. The thoracic walls at the superior and middle portions contract but little with expiration, and the enlargement with inspiration is slight. The dyspnœa, however, especially when increased by any superadded cause affecting hæmatosis, such as exercise, the existence of bronchitis, or bronchial spasm, gives rise to extraordinary efforts to expand the chest. The effect of these efforts, so far as they are exerted on the thoracic walls, is to elevate the ribs; and, as the costal cartilages are already straightened by the permanent expansion, the elevation of the ribs carries the sternum upward, so that the whole chest, including in some instances the clavicles, rises and falls with successive respiratory acts, as if it were a solid bony case.

The diaphragm participates in these exaggerated efforts; but if the emphysema extend to the lower lobes, the range of the diaphragmatic movement is diminished, and the rising and falling of the abdomen is less than in health. If the emphysema be accompanied by bronchial obstruction, the lower part of the sternum, the epigastrium, and inferior portion of the chest, laterally, are depressed with inspiration, the natural movements being reversed. This arises from the depression of the diaphragm elongating the lung, producing a vacuum which is not filled with sufficient rapidity by the air received into the bronchial tubes, and consequently the weight of the atmosphere presses the walls of the chest inward. This is less marked in aged persons in whom ossification of the costal cartilages has taken place.

The lateral anterior intercostal depressions at the lower part of the chest, are generally deeply marked with the act of inspiration in proportion to the exaggerated diaphragmatic effort; and at the summit of the chest, the spaces above and below the clavicles are not infrequently depressed with this act.

The foregoing account of the aberrations of motion have reference, for the most part, to the appearances manifested on both sides of the chest in cases in which both lungs are affected to a considerable extent. If the disease be limited to one lung, the dyspnœa is not sufficient to give rise to the general effects just described. On comparison of the two sides, under these circumstances, a marked disparity will be observed as regards permanent expansion, reduced range of motion with the successive acts of respiration, etc. Cases in which the emphysema is limited to one side are rare; but, as has been seen, when both lungs are affected, it is seldom that there does not exist an inequality in the amount of the affection in the two sides. The effects on the respiratory movements, as well as on the size and form, will then be more marked on the side which is most affected, the disparity as regards the signs furnished by inspection corresponding to the differences developed by a comparison of the results of percussion and auscultation.

Mensuration affords a means of verifying the abnormal changes in size and the aberrations of motion, which are determined sufficiently for diagnosis by inspection. To state the results furnished by this method would be, for the most part, to repeat what has just been presented.

Palpation furnishes some signs of importance. The alterations in shape, the condition of the intercostal spaces, the mobility of portions of the chest, the direction of the ribs, and their movements relatively to each other, are points which are ascertained by the touch as well as and in some respects better than by the eye. The sense of resistance, of which a judgment is formed incidentally while practising percussion, may be made a separate object of examination, and it then falls under the head of palpation. As respects the vibratory thrill communicated to the thoracic walls by the voice, and felt by the hand applied to the chest, in other words the vocal fremitus, it is found to vary in different cases, being in some instances increased, oftener diminished, and in other instances remaining unaffected. There is no constancy of relation between this sign and the affection; hence, in its bearing on the diagnosis, it is unimportant.

Examination with the hand is important in order to ascertain the situation of the heart. The absence of the cardiac impulse in the præcordia, shows this organ to be removed from contact with the thoracic walls. When it is depressed to the neighborhood of the epigastrium, its pulsations may be felt to the left of the ensiform cartilage. The impulse is not infrequently transferred to this situation.

Diagnosis.—The physical phenomena incident to vesicular emphysema, as already remarked, are highly distinctive of the affection. With an adequate knowledge of these phenomena the diagnosis is sufficiently easy and positive. Without the advantage which this knowledge affords, the symptoms might be supposed to denote some other disease of which dyspnœa is a prominent feature, for example, disease of the heart, aortic aneurism, chronic pleurisy, pneumo-hydrothorax, capillary bronchitis, pneumonitis, and acute phthisis. It will suffice to mention the more important points involved in the differential diagnosis from the several affections just named.

From heart disease emphysema is distinguished by the absence of the physical signs of the former, except it has become developed as a complication. If the complication have occurred, the previous history, in general, affords evidence of disturbance of the respiration for a long period prior to palpitations, or other symptoms of cardiac disturbance. With or without the conjunction of the symptoms and signs of disease of heart, the existence of emphysema is evidenced by the combined physical phenomena distinctive of the affection, which have been fully considered.

Aneurism of the aorta may cause a partial enlargement of the chest from the pressure of the tumor. But over the enlargement the percussion sound will be dull or flat, in place of the increased sonorousness due to rarefied lung. The positive signs of emphysema will be wanting, while, on the other hand, an aneurismal tumor has its positive signs, viz., pulsation, thrill, and a bellows' sound, synchronous with the heart's action.

I have known the affection to be mistaken for chronic pleurisy. In this instance (to which reference has been already made) the dilatation was limited to the left side. This side on mensuration was found to be larger than the right, which was apparent on inspection, and the intercostal depressions were effaced. Judged by these appearances, without the information furnished by percussion and auscultation, the existence of chronic pleurisy would be inferred, in view of the great infrequency of emphysema, to that extent, limited to one side. A vesiculo-tympanitic percussion-sound, extending to the base of the chest, in connection with feebleness of the respiratory murmur, and abnormal fulness above and below the clavicle on the left side, were the positive signs of emphysema; the absence of flatness, or at least absence of vesicular resonance, excluding pleurisy with an amount of liquid effusion sufficient to produce obvious dilatation.

So far as physical signs are concerned, the affection to which emphysema bears the nearest resemblance is pneumo-hydrothorax. In pneumo-hydrothorax the presence of air in the pleural sac causes dilatation of the chest, abnormal sonorousness on percussion, and suppression of the vesicular murmur of respiration. But as regards the physical phenomena, circumstances distinguishing the two affections are sufficiently marked. In pneumo-hydrothorax the percussion-resonance is purely tympanitic, while in emphysema the vesicular quality of sound is diminished but not lost. The latter affection never acquires the extreme drum-like sonorousness which characterizes dilatation of the chest from air within the pleural sac. In pneumo-hydrothorax the sonorousness extends to a certain distance from the summit of the chest, and below the point to which it extends, there exists flatness on percussion, owing to the presence of liquid. In emphysema, when the affection is limited to the superior portion of the lung, the percussion-resonance is clear at the lower part of the chest. Pneumo-hydrothorax is always confined to one side of the chest; this is very rarely true of emphysema. Moreover, pneumo-hydrothorax has its characteristic physical signs, which never occur in connection with emphysema, viz., amphoric respiration, metallic tinkling, splashing on succussion. In 49 of 50 cases, pneumo-hydrothorax occurs from perforation in the course of tuberculosis of the lungs, and the existence of the latter disease is shown by the pre-existing and coexisting signs and symptoms.

Emphysema complicated with ordinary acute bronchitis, presents certain of the diagnostic features of bronchial inflammation seated in the minute tubes. In capillary bronchitis the percussion-sound may be exaggerated, and become vesiculo-tympanitic. The dyspnœa in both cases may be extreme. The one affection is attended with great danger, the other, however distressing the symptoms, is rarely dangerous. The symptoms and signs, taken in connection with the previous history, suffice for the discrimination. Capillary bronchitis is accompanied by great acceleration of the pulse; in emphysema with ordinary bronchitis the pulse is moderately if at all increased in frequency. In capillary bronchitis the sub-crepitant rale is diffused over the chest on both sides, especially over the posterior surface; in emphysema it is an occasional sign, and never so much diffused. Capillary bronchitis occurs especially in childhood. Emphysema, sufficient to give rise to great disturbance of the respiration in connection with ordinary bronchitis, is rarely observed in early life. In cases of emphysema, in which the symptoms are rendered severe by an intercurrent ordinary bronchitis, the previous history, in the vast majority of cases, shows clearly the existence for a long period of dilatation of the cells, and in a large proportion of instances the patient is subject to attacks of asthma. These circumstances have an important bearing on the differential diagnosis, not only from capillary bronchitis, but other affections with which it may possibly be confounded.

From pneumonitis and acute phthisis (to which may be added dilatation of the bronchia), the differential diagnosis is settled at once by the physical signs. In each of these affections there are present the physical phenomena denoting solidification of lung, viz., dulness on percussion, bronchial respiration, increased vocal resonance or bronchophony, and exaggerated fremitus. These points of distinction are abundantly sufficient, irrespective of those pertaining to symptoms and pathological laws, which are also distinctive.

In conclusion, the diagnosis of emphysema requires only an acquaintance with its symptoms, signs, and pathological laws. With this knowledge it is recognized without difficulty in cases in which the dilatation of the cells is sufficient to give rise to the characteristic phenomena of the affection.

SUMMARY OF THE PHYSICAL SIGNS BELONGING TO VESICULAR EMPHYSEMA.

Exaggerated sonorousness on percussion, with a few exceptions. The resonance vesiculo-tympanitic. Sense of resistance increased. Feebleness, and in some instances suppression of the respiratory murmur. Inspiratory sound shortened (deferred); expiration prolonged, but the pitch of expiration not higher than that of inspiration. The bronchial rales denoting bronchitis, pulmonary catarrh, or spasm, often present, especially the dry rales, and usually more marked with expiration. The inspiratory movements quickened and shortened, and those of expiration prolonged. The chest generally or partially enlarged, more or less, within the limits of a full inspiration. The space above and below the clavicle occasionally bulging. The intercostal depressions sometimes effaced. Curvature of the dorsal portion of spine forward, if the disease be general and of long standing. The whole chest, in cases in which the affection is sufficient in degree and extent to give rise to dyspnœa, elevated as one piece, in inspiration, with but slight expansion. The movements of the diaphragm restrained. The beating of the heart not felt in the præcordia, but in some instances at the epigastrium.

INTERLOBULAR EMPHYSEMA.

In this form of emphysema air is extravasated into the areolar structure, uniting together the pulmonary lobules. The morbid condition is identical with emphysema seated beneath the external tegument of the body. To the latter, indeed, it may give rise, the air following the roots of the lungs into the mediastinum, thence into the subcutaneous areolar tissue of the neck, and becoming more or less diffused. Interlobular emphysema is almost invariably traumatic, arising from rupture of the air-vesicles in consequence of violent respiratory efforts. It is an exceedingly rare affection. The anatomical characters consist of enlargement of the interlobular septa, the increased size being greater toward the surface of the lung, causing them to assume a wedge-like shape; and detachment of the pleura by the pressure of air beneath this membrane, producing air-bladders, variable in size and more or less numerous. These air-bladders sometimes attain to a considerable magnitude. I have seen a globular tumor, thus formed, as large as an English walnut, and they have been observed still larger. In a case reported by Bouillaud, there existed a sac so large that it resembled the stomach. They are movable by pressure; and if there are several they may be made to coalesce. Similar sacs are sometimes found beneath the surface, differing from those caused by coalescence of the air-vesicles in the fact that they are seated in the interlobular areolar structure. In some cases the surface of the lung is studded with numerous small elevations of the pleura, presenting an appearance compared by Rokitansky to that of froth. Close examination of sections of lung affected with interlobular emphysema, shows the air-vesicles to be unaffected, except by the pressure of the enlarged septa, and the cavities formed in the areolar tissue.

This form of emphysema occurs in children more frequently than in adults. It is oftener situated in the upper than in the lower lobes, and is most prone to occur along the anterior borders of the upper lobe.

The symptoms will be those incident to defective hæmatosis, this being proportionate to the extent to which the air-vesicles are compressed by the abnormal size of the interstitial areolar tissue, and to the mechanical obstacle to the expansion of the lungs from the presence of sub-pleural extravasation. Cases have been reported in which sudden death was attributed to the rapid escape of air from the cells into the areolar tissue. Rupture of the pleural air-bladders may take place, giving rise to pneumothorax, and collapse of the lung. Owing to the great infrequency of the affection, the histories of well-attested cases have not as yet accumulated sufficiently to furnish data for its symptomatic characters; or, at all events, an analysis of recorded cases is yet to be made.

The remark just made with respect to symptoms, will apply equally to physical phenomena. Laennec attributed to this affection two signs, neither of which have been found by subsequent observation to possess the significance attached to them by the discoverer of auscultation. One of these is the indeterminate sign styled by Laennec the dry crepitant rale with large bubbles (*râle crépitant sec à grosses bulles*); and the other a friction sound (*bruit de frottement*). The first of these two signs is so doubtful in its character, as well as in its relation to pathological conditions, that it is clinically unimportant. The second may possibly be present in some cases of interlobular emphysema, but occurs in the vast proportion of instances in connection with inflammation of the pleura. The rarefaction of lung induced by the presence of air in the areolar structure must, of course, give rise (except the tension of the thoracic walls be very great) to exaggerated sonorousness on percussion; and, also, to feebleness of the respiratory murmur in proportion as the air-vesicles are compressed and the expansion of the lung restrained. The effects of this variety of emphysema on the configuration and size of the chest, as well as on the respiratory movements, remain to be studied. The combination of the physical signs furnished by percussion and auscultation is, thus, the same as in the ordinary form of emphysema, viz., dilatation of the air-cells. The differential diagnosis from the latter, with our present knowledge of the subject, so far as the symptoms and signs referable to the chest are concerned, would be impracticable. Circumstances in some cases incidental to the affection, may enable the physician to make the discrimination clinically. If the physical signs and symptoms denoting rarefaction of lung are developed suddenly, or with more or less rapidity, evidently proceeding from an injury occurring in connection with some unusual effort of the respiratory organs; for example, after violent coughing, the straining of parturition, a strong mental emotion, etc., the probability is that the emphysema is traumatic and interlobular. If subcutaneous emphysema of the neck occur under these circumstances, the diagnosis is rendered quite positive. External emphysema, however, unless it occur in conjunction with the physical signs denoting rarefaction of lung, is not evidence of this morbid condition, for it may proceed from rupture of the trachea or bronchi exterior to the pulmonary organs. Happily, owing to the great infrequency of this variety of emphysema, the absence of traits sufficiently distinctive to warrant a positive diagnosis in all instances, is rarely the occasion of embarrassment in medical practice.

CHAPTER V.

PULMONARY TUBERCULOSIS—BRONCHIAL PHTHISIS.

The affection called pulmonary tuberculosis, phthisis pulmonalis, or pulmonary consumption, involves as the point of departure for a series of destructive processes, the deposit in the lungs of the heteromorphous product, tubercle. The nature of this product, the precise situation at which it is first deposited, its varying characters, the metamorphoses which it undergoes, and the structural changes incident to the progress of the disease, are subjects which could not be touched upon without risk of being led into details inconsistent with the limits, as well as the plan of this work. Presuming the reader to have a general acquaintance, at least, with the morbid anatomy of the disease, I shall simply enumerate the abnormal conditions which stand in immediate relation to the phenomena furnished by physical exploration. The presence of tubercle causes, in proportion to its quantity, an increased density of the affected lung. Existing in the form of small isolated deposits, more or less numerous, the intervening pulmonary parenchyma being healthy, it constitutes a form of miliary and disseminated tubercles. The increased density due to the presence of tubercles, either discrete or distributed in small clusters, may be but slight, but will, of course, correspond to their abundance and approximation to each other. Obstruction to the entrance of air into the cells, from the pressure of the tubercles on the small bronchial tubes, may not only abridge the respiratory processes in the part or parts affected, but cause a reduction in volume by collapse, more or less, of the cells not filled with tuberculous matter, and thus the density is still farther increased by condensation. The physical conditions represented by certain signs under these circumstances generally fall short of those incident to a more abundant exudation, when the deposits no longer remain isolated, but enlarging by constant accretion, they at length coalesce and form continuous solid masses, frequently attaining to a considerable size. The latter constitutes more emphatically tuberculous solidification, and a corresponding difference pertains to the representative physical signs. So, also, if the tubercles be disseminated, and the intervening parenchyma become consolidated by inflammatory exudation, or infiltration of tuberculous matter (which not infrequently occurs), the physical conditions are the same, a continuous solidification in this case equally existing.

The occurrence of circumscribed inflammation of the pulmonary parenchyma surrounding tuberculous deposits, preceding inflammatory exudation and solidification, may give rise to the auscultatory sign pathognomonic of pneumonitis, viz., the crepitant rale, and taken in connection with certain circumstances, as will be seen, this sign is evidence of tuberculous disease.

The processes of softening, ulceration, and evacuation of the liquefied tuberculous matter, leaving pulmonary, excavations, give rise to anatomical conditions quite different from those which pertain to the presence of crude tubercle, and these new conditions are represented by peculiar signs. But whereas, the fresh deposition of tubercle is usually going on while cavities are forming, and after they have formed, tuberculous solidification generally surrounds the excavations, and crude tubercles, in greater or less abundance, are distributed throughout the pulmonary parenchyma. Hence, the physical signs of different stages of the progress of tuberculous disease, viz., solidification and excavation, are likely to be conjoined. The size of excavations, their situation, their number, and even the firmness of their walls, as well as the varying contingent conditions relating to their contents, are found to affect the physical phenomena to which they give rise.

The bronchial tubes in proximity to tuberculous deposits and excavations, are the source of physical signs. Circumscribed bronchitis, as will be seen, is evidence of the existence of tuberculosis. The presence of liquid in the tubes, either produced by bronchitis or derived from cavities, and the perviousness of the bronchiæ, constitute important physical conditions.

The loss of expansibility of lung solidified by tubercle, and the reduction in its volume which frequently ensues from collapse and destruction of pulmonary tissue, furnish conditions which are represented by physical signs.

The attacks of circumscribed dry pleuritis which occur from time to time almost uniformly over tuberculous portions of lung, may also give rise to phenomena which become, inferentially, evidence of tuberculosis.

Abnormal dilatation of air-cells, or emphysema, affecting more or less of the lobules in the vicinity of tuberculous deposits, is another morbid condition incidental to the disease in a certain proportion of cases, modifying the physical phenomena, and is not therefore to be lost sight of in clinical investigations.

Systematic writers generally divide tuberculous disease of the lung into three stages, viz.: 1. Stage of crude tubercle; 2. Stage of softening; 3. Stage of excavation. With reference to the study of physical signs and their application to diagnosis, a more convenient division, as it seems to me, is the following: (*a*.) Small, disseminated tuberculous deposits; (*b*.) Abundant deposition, involving considerable solidification; (*c*.) Tuberculous disease advanced to the formation of cavities.[1] I shall consider the physical signs and the diagnosis with reference to these three forms and periods of the disease.

The following laws of pulmonary tuberculosis will frequently be referred to. The deposit in the vast majority of cases takes place first at or near the apex of the lung. Exceptions to this law are occasionally observed. The deposit takes place at the summit of the lung on one side before the other lung is attacked; but the opposite lung is subsequently affected in the vast majority of instances. Hence, in the bodies of persons who have died with tuberculosis, the two lungs almost invariably are found to be diseased, but the deposit is most abundant or the ravages are more extensive on one side. These laws are of fundamental importance in diagnosis.

The claims of pulmonary tuberculosis on the attention of the medical student and practitioner are sufficiently obvious in view of its great prevalence and mortality in all countries. But the study of its diagnosis is rendered immensely important by the fact that the prospect of exerting a control over the disease, and diminishing its tendency to a fatal issue, is in proportion to its early recognition.

Pulmonary tuberculosis, as the rule, is essentially a chronic affection. The chronic form is understood by the simple expression pulmonary tuberculosis. Occasionally, however, the rapidity of its career and the intensity of its symptoms denote an acute affection. Acute phthisis, I shall notice briefly under a distinct head. This chapter will also embrace a few remarks on the retrospective diagnosis of pulmonary tuberculosis, and on the diagnosis of bronchial phthisis.

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[1] To consider a stage of softening, as distinct from the stage of excavation, may be correct as regards the morbid anatomy of the disease, but clinically it seems to me to be a needless division. The physical signs supposed to indicate such a stage are of doubtful significance. Hence, it will be observed that I do not undertake to point out means by which it may be recognized.

Physical Signs.—The clinical history of pulmonary tuberculosis embraces signs furnished by all the different methods of physical exploration.

The phenomena developed by *percussion* are highly important. They are by no means altogether uniform at different periods of the disease, nor in different cases at the same period, varying with the various anatomical conditions just enumerated, and also affected by circumstances not included in that enumeration.

Diminution of the normal vesicular resonance is a constant result of a tuberculous deposit, sufficient in amount to give rise to other signs, or to marked pulmonary symptoms. The varieties of percussion-signs consist of abnormal modifications of sound superadded to deficiency of vesicular resonance. Simple dulness, slight or moderate in degree and more or less extensive, at the summit on one side, compared with the resonance on the other side, is the evidence commonly afforded, by percussion, of the existence of small disseminated collections of tubercle. To determine the fact of slight or moderate relative dulness, percussion is to be practised alternately at corresponding points on the two sides, observing all the precautions which have been pointed out in the chapter on percussion in the first part of this work. These precautions are essential if we would avoid errors. The symmetrical conformation of the two sides of the chest is to be ascertained. Slight or moderate dulness, on one side, ceases to be a morbid sign if, from spinal curvature, antecedent pleurisy, or other causes, this symmetry be disturbed. The natural disparity between the two sides at the summit which is habitual in many persons, must also be taken into account. It is to be borne in mind that, as a rule, in the majority of healthy persons with well-formed chests, the percussion-sound in the left infra-clavicular region has more sonorousness, more of the vesicular quality, and is lower in pitch, than in the corresponding region on the right side. Hence, distinct dulness, however slight, on the left side, is highly significant, while on the right side, if slight or moderate, it is to be taken as a morbid sign with considerable reserve. Distinct dulness at the left summit, be it ever so slight, in connection with the diagnostic symptoms of tuberculosis, may almost suffice to establish the fact of the existence of the disease, when, if situated on the right side, other corroborative evidence is requisite.

Delicacy of hearing, and a nicety of discrimination acquired by practice, undoubtedly enable one person to detect, promptly, a disparity in sounds elicited by percussion, when, to a person whose auditory sense is more obtuse and uncultivated, it is not apparent. A person with a musical ear recognizes a variation in the pitch of sound more readily than a difference in the amount of sonorousness, or of vesicular quality; hence, it is useful to bear in mind that, as a rule, when the sound is dull it is at the same time raised in pitch. In making a close comparison, however, the attention should be directed to the several elements combined in diminished vesicular resonance, viz., usually lessened sonorousness, deficiency of the vesicular quality, shortened duration of sound and elevation of pitch. But it is rarely the case that the quantity of tuberculous deposit, when it exists, is so small as to require extraordinary skill, either in eliciting or appreciating the results of percussion.

Disparity in the percussion-resonance, from a source extrinsic to the thorax, I am satisfied, exists oftener than is to be inferred from the results of the analysis of the recorded examinations given under the head of Percussion in Health, in Part I. I refer to transmitted gastric tympanitic resonance. It is not very uncommon to find the sound at the summit of the left side obviously modified by this disturbing element.

In practising percussion at the summit of the chest with reference to the existence of small tuberculous deposits, the clavicular, post-clavicular, and infra-clavicular regions in front, and the upper and lower scapular regions behind, are to be examined. Owing to the difficulty of making equal percussion in the post-clavicular region, a disparity limited to this situation is to be distrusted, unless it be extremely marked. I have, however, noted very distinct dulness here, in undoubted cases of tuberculosis, when it was not appreciable in the clavicular and infra-clavicular regions. Over the scapula the evidence afforded by percussion is often extremely valuable, corroborating that obtained in front, the disparity sometimes being marked in this situation, when it is slight and even wanting in the anterior regions. Percussion here is the more valuable because a natural disparity between the two sides exists less frequently than in front; when present, however, the rule being the same, viz., less resonance and elevation of pitch on the right side.

Of the relative proportion of instances in which dulness is found in the several regions, respectively, at the summit of the chest, in cases of small tuberculous deposit, some idea may be formed by the following analytical results. Out of 100 examinations in different cases of tuberculosis, in 22, from the aggregate of physical signs, the quantity of tubercle was presumed to be small. In each of these 22 examinations, dulness at the summit was distinct, being either slight or moderate in degree. In 14 cases the fact of dulness at the summit is simply recorded; in 9 cases the particular situations of the dulness are specified. Of the latter 9 cases, the dulness existed in the post-clavicular region in 7, in the clavicular region in 6, in the infra-clavicular region in 6, and over the scapula in 9. Of the 22 cases, in 10 the evidences of the deposit were manifested on the left, and in 12 on the right side. These 100 cases, which will be repeatedly referred to, are taken in order from my clinical records, beginning with the last case recorded. The number, which might have been much larger, it is presumed is sufficient for the present objects of analysis.

If the tuberculous deposit be abundant, the evidence of its presence afforded by percussion, in general, consists in a corresponding amount of dulness. The disparity at the summit of the chest is sufficiently obvious, requiring no unusual delicacy of manipulation or of the sense of hearing to elicit and discover it. The degree of diminution of the vesicular resonance is a measure of the completeness with which the lung is consolidated, and the area over which this resonance is found to be impaired or lost, is proportionate to the diffusion of the solidification. Dulness under these circumstances is not invariable. In complete and considerable solidification at the summit of the chest, the percussion-sound may be abnormally clear, the sonorousness even exceeding that of the opposite side. So far as my observations go, this anomaly occurs only on the left side, and in the few instances in which I have noted its occurrence, from the coexistence of marked gastric resonance at the inferior portion of the chest on that side, it is fair to conclude that in great part, at least, the sonorousness was transmitted from the stomach. However this may be, the sound is not a vesicular resonance; it is tympanitic, *i. e.* devoid of the vesicular quality, and elevated in pitch. With due attention to the quality and pitch of the sound, it need never be mistaken for a normal resonance, and the lesser sonorousness of the opposite side in consequence be attributed to disease. Other signs, moreover, will concur to prevent such an error.

Without exceeding in sonorousness the resonance on the opposite side, the percussion-sound over tuberculous solidification may be more or less clear and tympanitic. The sonorousness is diminished, but the diminution of the vesicular quality of resonance is greater than the loss of clearness. To quote the happy expression employed by Dr. Stokes, there exists, under these circumstances, "tympanitic dulness." The source of the tympanitic resonance, which thus, in a certain number of cases, replaces the vesicular, in connection with tuberculous solidification, when not transmitted from the stomach or intestines, as stated in Part I, must be the air contained in the bronchial tubes, or emphysematous dilatation of the air-cells, surrounding the solidified portion of lung; or both may be combined. The occasional coexistence of emphysema affecting lobules in the vicinity of tuberculous deposits, is a fact belonging to the morbid anatomy of pulmonary tuberculosis, which was enumerated among the conditions modifying the physical signs. If the tuberculous deposit be abundant, but the solidification of lung not complete, then the vesicular resonance will not be wholly lost, but more or less diminished. And under these circumstances, the conditions giving rise to tympanitic resonance will cause a combination of diminished vesicular and of tympanitic resonance in various and varying proportions; the sound, in other words, elicited by percussion will be vesiculo-tympanitic, the vesicular or the tympanitic quality predominating in different cases.

Judging from my observations, I should say that in cases of abundant tuberculous deposit (of course not advanced to excavation), the diminution of the vesicular resonance is accompanied, as a rule, by more or less of tympanitic sonorousness, but the former, *i. e.* the dulness, is the more obvious element, and the latter, *i. e.* the tympanitic quality of sound, is overlooked if it be not unusually prominent, unless the attention be directed particularly to it. On the other hand, in a small proportion of cases, the percussion-sound over tuberculous solidification is dull almost to flatness.

The tympanitic resonance due to transmitted gastric sonorousness on the left side, at the summit, may prevent dulness at the summit of the right side, dependent on an abundant deposit of tubercle, from being readily appreciated. I have noted an instance of this description, the auscultatory phenomena showing the existence of a considerable quantity of tuberculous matter at the summit of the right lung.

An abnormal sense of resistance is a valuable collateral means of determining the fact of tuberculous solidification, in the practice of percussion. Especially is this point important when there is found to be only a moderate relative dulness on the right side, which we may not be altogether certain is not due to a natural disparity. An increased sense of resistance in concurrence with the dulness, confirms its morbid character.

Irrespective of the quality of the resonance which remains, marked dulness on percussion, as already stated, over the site of an abundant tuberculous deposit, is the rule. Out of 100 examinations of different cases of pulmonary tuberculosis, of which I have transcribed the recorded physical signs for the sake of reference in writing these remarks, excluding the cases in which the quantity of tuberculous deposit was small, and also the cases in which the evidences of excavation were ascertained, 65 cases remain of more or less complete and extensive solidification depending upon abundant tubercle. In 35 of these cases the dulness is noted to have been marked, and in several instances the fact of dulness is alone stated without expressing its degree. In five instances the percussion-sound was almost flat. In three cases only was there greater sonorousness, tympanitic in quality, over the solidified lung, and in each of these instances the left side was the seat of the solidification, and gastric resonance was marked over the whole of the left side. With a single exception, whenever the different regions of the summit were specified, the diminished vesicular resonance was observed over, above, and below the clavicle in front, but frequently more marked over the scapula behind. In the single exceptional instance just referred to, a disparity was marked over the scapula and not in front. It was often sufficiently obvious that the resonance was diminished at the summit on both sides. The existence of marked relative dulness in front on one side, and an equally marked relative dulness over the scapula on the other side, is also noted.

When tuberculosis has advanced to the formation of cavities, the phenomena furnished by percussion vary, not only in different cases, but often in the same case at different examinations made during the same day, the latter variations depending on the state of the excavations as respects their liquid contents. More or less tuberculous solidification continues after cavities are formed; and if, in addition, the cavities are filled with liquid, the physical conditions favorable to marked dulness or even flatness on percussion are eminently present. But if they are empty, and of considerable size, they may give rise to an abnormally clear and tympanitic percussion-sound, which occasionally presents other and more characteristic modifications of quality, viz., the amphoric and the cracked-metal varieties of tone. So far as percussion is concerned, the evidence of the existence of excavations consists in the signs just mentioned, viz., tympanitic resonance and the amphoric and cracked-metal modifications. How far are these phenomena available in determining the existence of excavations? A tympanitic sonorousness, as we have seen, may replace the vesicular resonance over tuberculous solidification, and the tympanitic sound, under these circumstances, may be quite intense at the summit of the left side. When incident to solidification, the tympanitic quality is considerably diffused. On the other hand, if it be due to the presence of air in a cavity, it is circumscribed in proportion to the limited size of the excavation. This is a differential point. Another point relates to the percussion-sound over the portions of the chest adjoining the space to which the tympanitic sonorousness is limited. Tuberculous excavations being usually surrounded by solidified lung, the limits of the circumscribed tympanitic sonorousness may be somewhat abruptly defined by a dulness which contrasts strongly with the sound elicited over the cavity. It is possible in some instances, by careful percussion, to delineate on the chest, by means of this abrupt change from a clear to a dull sound, the site of an excavation. The alternate presence and absence of tympanitic sonorousness in the same situation at different examinations is a diagnostic point. By taking the necessary pains to practise percussion very early in the morning, before the contents of an excavation are expelled, and subsequently after an abundant expectoration, the change from marked dulness to clearness of resonance in a particular part of the chest may be ascertained, and thus shown to depend on the removal of morbid products, which, in view of other signs and symptoms, we cannot doubt came from a cavity. The modifications of tympanitic resonance called amphoric and cracked-metal, in themselves are highly significant of a tuberculous cavity. Both may occur independently of excavation, as has been pointed out in Part I, but the instances are exceptional and rare. Inasmuch, however, as these modifications are only occasionally observed when cavities undoubtedly exist, their absence is not evidence of the non-existence of excavation. They have a positive significance when present, but in a negative point of view are unimportant.

In a considerable proportion of cases of tuberculosis advanced to excavation, percussion fails to develope any distinct evidence of the existence of cavities. This remark will be found presently to be also applicable to the other methods of exploration. The reason is, that in addition to the existence of excavations, various contingent circumstances must be combined, in order that the distinctive signs shall be produced. The circumstances favorable for the characteristic percussion-signs, and at the same time most of the distinctive phenomena derived from other methods of exploration, have been already mentioned (Part I), but they may be repeated in this connection. The size of the cavity is important. It must have attained to a certain magnitude, and, on the other hand, should not be too capacious. It must be empty, or at least only partially filled with liquid. Its situation relative to the superficies of the lung is important. The thinner and the more condensed the stratum of the lung separating the cavity from the thoracic wall, the greater the tympanitic sonorousness; and it is a still more favorable circumstance if over the excavation the pleural surfaces have become firmly adherent. The incompleteness with which these circumstances are conjoined in many cases, and the occasional absence of the indispensable condition pertaining to the contents of the cavity, sufficiently account for the infrequency with which the existence of excavations is positively ascertained, especially at a single examination.

Of the 100 examinations already referred to, in 13 the physical signs were considered to denote the existence of excavations. It is, however, more than probable that among the 65 cases of abundant tuberculous deposit, were many cases in which the disease had advanced to the formation of cavities, the physical signs at the time of the recorded examination indicating only solidification. Of the 13 cases, in 6 circumscribed tympanitic sonorousness existed, which was attributed to empty excavations. In some of these cases the existence of cavities was subsequently verified by autopsical examinations. In 4 cases the amphoric modification, and in 2 the cracked-metal intonation was noted.

In leaving the subject of the percussion-signs belonging to tuberculosis, two or three rules, with respect to the practice of percussion may be mentioned, which are to be borne in mind, particularly in cases in which the tuberculous deposit, if it exist, be small. The importance of observing the general precautions pointed out in the chapter on percussion in Part I, has been already adverted to. In cases of doubt, it is useful to compare the chest as regards the results of superficial and deep percussion alternately. Slightly increased density near the surface of the lung on one side may give rise to dulness on light percussion, when with forcible strokes the disparity

less marked when the chest is fully expanded. It is,
recollected, that a disparity in this way sometimes bec
in health. Percussion at the summit behind shoul
glected. This rule is to be impressed the more, bec
said by a late author on diseases of the chest, that
no value over the scapula. This, if I mistake not, is
pression. A comparison of the two sides as respects
and pitch of resonance, may be made here, as well a
tions. My observations have taught me that a relat
one side from tuberculous deposition is more unifor
in this situation than in front. Moreover, as stated
Louis, the tuberculous deposit is in some instances
upper and posterior portion of the lung, and under these
the physical signs are limited to the scapular region.

During the existence of hæmoptysis, or in cases
symptom has very recently occurred, percussion shoul
very cautiously. Deep percussion should be refrained
known profuse hemorrhage to follow so closely on an
the chest, that it was fair to conclude the force of the
been the exciting cause.

Finally, a variation in a percussion-resonance be
sides, which exists irrespective of deviations from sym
mation or a natural disparity, may proceed from mo
other than tubercle, so that this sign, exclusively of
of symptoms, by no means invariably denotes tubercul
emphysematous condition, for example, on one side,
obvious disparity. The converse of the above state

sated for, and a disparity in the percussion-sound is not obvious. This may be true occasionally, as regards mere sonorousness, or the degree of resonance; but under the circumstances just mentioned, the quality and pitch of sound can hardly fail to undergo an appreciable alteration: the resonance, although not less clear than on the opposite side, becomes vesiculo-tympanitic and raised in pitch. The importance of analytically resolving the sound elicited by percussion over the chest into its different elements, and studying the abnormal modifications which these elements may respectively undergo, is illustrated in the instance just cited.

The auscultatory phenomena belonging to the clinical history of pulmonary tuberculosis, embrace the greater part, if not, indeed, the whole of the catalogue of the physical signs furnished by this method of exploration. In their relation to the disease the following distinction may be made: the adventitious sounds, viz., the rales and friction-sounds, are contingent or accidental phenomena, occasionally present, and although possessing, when present, diagnostic significance, their absence does not constitute any ground for inferring the non-existence of the disease. On the other hand, the signs which are included in the class of modified respiratory sounds, are more intimately and constantly connected with the morbid conditions incident to the disease. They are therefore more important as diagnostic criteria, and they are important in a negative point of view. If the respiratory sounds are free from any abnormal modification, a tuberculous deposit can hardly exist. The fact enables us to exclude the disease.

In cases of small, disseminated tuberculous deposits, so far as the phenomena consist of modified respiratory sounds, they will mostly come under the head of broncho-vesicular respiration. In the sense in which I have used this term, it embraces all the elements of the bronchial respiration, except that the inspiratory sound is not wholly tubular, but presents the tubular and vesicular qualities combined. It is the *rude* respiration of writers on the subject of physical exploration, sometimes also styled *harsh* and *dry* respiration. If all the characters of the broncho-vesicular respiration are present, we shall have an inspiratory sound neither purely tubular nor vesicular in quality, but a mixture of both (broncho-vesicular), the duration somewhat shortened (unfinished), the pitch raised; a brief interval, followed by an expiratory sound, prolonged, frequently longer and more intense than the inspiration, and higher in pitch. Sometimes in connection

with a small amount of tuberculous disease all these characte
observed, but oftener more or less of them are wanting. Th
sence of certain of the broncho-vesicular elements, and the
of others, give rise to considerable diversity in different cases.
diversities it will be useful to study with a little detail. It i
less to remark that in determining the existence and the cha
of abnormal modifications of the respiration, auscultation is
practised at the summit of the chest on both sides, and the
mena carefully compared. On the side affected, the intensity
respiratory sound may be either increased or diminished. It is
oftener diminished,[1] but when it is not too feeble to be dis
heard, if the lessened intensity be due to increased density of lun
duced by tuberculous disease, it is always altered in other partic
in other words, more or less of the broncho-vesicular characte
added, these characters being independent of the intensity
sound. The fact just stated will serve to distinguish the feeble
ration due to tuberculous disease from that incident to simple e
sema. Occasionally the inspiratory sound is inappreciable,
Cammann's stethoscope be employed. On the other hand, the
ratory sound may be alone heard, *i. e.* without any sound of e
tion. The abnormal modifications will then consist of sho
duration, diminished vesicular or acquired tubularity of quality
elevation of pitch, pertaining, of course, exclusively to the in
tion. These three characters go together. The variation in
is frequently the character most readily recognized. *Rud*
harshness, and *dryness* of the sound, pertain to this characte
gether with the tubularity. These three characters are sho
contrast with the longer duration, the more marked vesicular qu
and the comparative lowness of pitch, which belong to the inspir
sound on the opposite side, or over the middle and lower third
chest on the same side. If an expiratory sound be present,
often, if not generally, more intense than the sound of inspir
Its intensity, however, varies. More or less prolonged, its dur
differs in different cases. It is uniformly higher in pitch tha
inspiratory sound, the disparity being in some cases much
marked than in others. A point of contrast between the two
of the chest in some instances is the presence of an expiratory

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[1] Fournet states that increased intensity of the respiratory sound is the first
induced by the deposit of tubercle (op. cit.). My observations lead me to an
conclusion, as stated above.

on one side and not on the other; and if diffused over both sides, its characters are the reverse of those which render it a sign of increased density of lung from tuberculous disease; they are relative shortness of duration, with less intensity and pitch lower than belong to the sound of inspiration. As the expiratory sound is sometimes wanting, so in some instances it is alone present, no sound of inspiration being discoverable. It is not uncommon in cases of tuberculosis to find the following results on comparing the two sides of the chest: on one side a vesicular inspiration, more or less intense, with no expiratory sound, and on the opposite side a prolonged, more or less intense and acute expiration, with a very feeble or scarcely appreciable sound of inspiration.

The diversities which different cases present as respects the presence or absence of more or less of the elementary characters of the broncho-vesicular respiration, are not of importance from their possessing respectively any special significance. The simple point practically is to determine the existence of any of the elements of the broncho-vesicular respiration. The broncho-vesicular respiration, in conjunction with other signs and with symptoms, is diagnostic of a tuberculous deposit not producing complete solidification, extending over a considerable space, at or near the apex of the lung. Its availability in diagnosis of course depends on its constancy, and the facility with which it may be recognized. Guided by the impressions derived from my own experience, I should say that cases belonging in the class of small, disseminated tuberculous deposits, are extremely rare in which certain of its elements are not sufficiently marked to be appreciated by one acquainted with the subject, and possessing a fair amount of skill as a practical auscultator.

In comparing the respiratory sounds at the summit of the chest, in front and behind, on the two sides, it is essential, if we would avoid errors, to make due allowance for the points of normal disparity existing in many persons in this part of the chest. These have been considered in the chapter on auscultation, in the first part of this work, to which, in the present connection, the reader is referred. It is to be borne in mind, that on the right side, at the summit, especially in front, the inspiratory sound is frequently less intense, less vesicular, and higher in pitch, than on the left side, and that a prolonged expiration on the right side, occasionally more intense and higher in pitch than the inspiratory sound, and sometimes existing alone, is observed in healthy persons. Hence, the character of the broncho-

obtains in cases in which there is every reason to su
lungs contain tubercles. In view of the fact that aft
deposit has taken place in one lung, in a short time
becomes affected, I have often been surprised at find
tion over the lung least affected nearly or quite nor
that under these circumstances we have not a health
as a standard of comparison, but without such a
practicable to judge of the pitch and vesicular quality
tion, and the relative intensity, duration, and pitch of
if the latter be present, and thus to determine whet
tion be broncho-vesicular or not. I can only acco
now referred to, by supposing that when the increase
summit of one lung is sufficient to occasion a distinct
the respiratory sound, the activity of the other lun
increased for the normal characters to be maintaine
ing the presence of a certain number of tubercles,
rise necessarily to a well-marked exaggerated respir
marked exaggerated respiration, as will be presentl
occur in the opposite lung in some instances, in whic
tuberculous deposit is considerable on one side.

Interrupted, wavy, or jerking respiration, is a mo
ring in a certain proportion of cases of small tube
but also observed occasionally when other signs and
do not denote tuberculous disease. Its value as a
therefore, depends on its being associated with oth
tuberculosis. In the 22 examinations in cases of sma

icant of a tuberculous affection when they occur under circumstances which warrant the inference that the particular morbid conditions which they immediately represent involve the coexistence of tubercles. Their relation to the disease, as already remarked, is therefore contingent or accidental.

A veritable, well-defined crepitant rale denotes pneumonitis in the vast majority of cases. Pneumonitis, occurring between the extremes of life, if it be circumscribed, *i. e.* extending over a portion only of a lobe, and situated at or near the apex of the lung, is highly significant of tuberculosis, because, in the first place, under these circumstances it is not primary, since primary pneumonitis extends over a whole lobe, and affects by preference the inferior lobe; and, in the second place, observations show that circumscribed pneumonitis is occasionally developed in the vicinity of tuberculous deposits, viz., at or near the apex of the lung. A crepitant rale is thus inferentially a diagnostic sign of tuberculosis when it is found at the summit of the chest, extending over a limited area. As respects the frequency of the occurrence of circumscribed pneumonitis, in connection with tuberculous disease, and the consequent frequency with which a crepitant rale well-marked (in distinction from dry crackling) becomes a sign of the latter affection, my experience accords with that of Dr. Walshe, viz., the coincidence is rare. It is not, however, less significant on this account when it does take place.

Dry crackling, as distinguished from a well-marked crepitant rale, consists of a few crepitations, apparently reaching the ear from a distance, generally confined to the end of the inspiratory act. Whatever opinion may be entertained of the mechanism of its production, observations show that it frequently occurs in the early stage of tuberculosis, and is rarely observed, at the summit of the chest, except there exist a tuberculous affection. Hence it possesses a certain degree of significance, especially when associated with other signs and with symptoms having a similar diagnostic bearing. Of the 22 examinations in cases presumed to be of small disseminated tubercles, it was noted in 9. In several instances it existed at the summit of the chest on both sides, but was more marked on the side which the associated signs indicated as the seat of the deposit.

The same remarks are applicable to a crumpling sound, except that the latter is much less frequently observed in cases of tuberculosis. For all practical purposes it suffices to consider this as a variety of crackling.

The occasional development of bronchitis, not
but the larger tubes in the vicinity of tubercles, i
ing to the natural history of pulmonary tubercu
production of sibilant, sonorous, and mucous rales
present morbid conditions pertaining to bronchit
limited to the upper portion of the lungs, and esp
one side, is not a primary affection. These restric
the laws of primary bronchitis, which is one of th
eases, and extends over the bronchial tubes distri
as well as the upper lobes. The physical signs of p
as has been seen, are especially manifested, not in
mit, but over the middle and lower portions of the che
when confined to the summit, and especially to or
chitis is secondary, and in this situation the probab
in favor of its being induced by tuberculous disease

Moist crackling or mucous rales may, however,
the escape of softened tuberculous matter into t
necessarily involving the coexistence of circumsc
The development of moist or bubbling sounds is ge
as a circumstance distinctive of the fact that soft
place. Undue significance, as it seems to me, has
this circumstance. It is impossible to determine fro
of the sounds whether they proceed from the pres
tuberculous matter, or from mucous secretions, or
case frequently) from both combined. And inas
scribed bronchitis may undoubtedly exist before
tuberculous matter ensues, mucous rales are heard

berculosis, and in cases of doubt it is useful to auscultate repeatedly, nd especially in the morning before expectoration has taken place, order to discover them, if they exist.

It thus appears that with respect to all the adventitious sounds or les just noticed, their diagnostic value in cases of tuberculosis epends on their being limited to a circumscribed space at the summit the chest. Their value is enhanced by association with other enomena, physical and vital, pointing to tuberculous disease. hey are occasionally, not constantly, present in cases of tuberculosis. hey cannot, therefore, be relied upon in the diagnosis; and, as ready remarked, although of importance when present, we cannot gue against the existence of tuberculous disease from their absence. s criteria of the disease, they are much less important than the enomena included under the title of the broncho-vesicular respiration.

An abnormal transmission of the heart-sounds, oftener observed d more marked in cases of abundant tuberculous deposits, may be a gn of some value when the affection consists of small disseminated bercles. If the sounds of the heart are heard with equal, if not eater distinctness, at the summit of the right as of the left side, it point the more worthy of attention from the difficulty of determining, in some instances, whether the characters of the broncho-icular respiration on the right side are due to a morbid source, merely to a natural disparity. This difficulty, which is an tacle in the way of the diagnosis when the tuberculous affection eated in the right lung, renders the collateral evidence of the ease in this situation of greater practical value than when the left g is affected. It is chiefly with reference to the detection of erculosis on the right side that this sign is useful; and, obviously, s a sign more available on the right, than on the left side.

Passing next to the auscultatory phenomena produced by the ce, an exaggerated vocal resonance is an important physical sign tuberculosis when it exists at the summit of the chest on the left e. On the other hand, a relatively greater degree of resonance the right side, in itself, has little or no diagnostic importance. is difference is owing to the normal disparity found in most persons, ecially in front. The greater intensity of vocal resonance on the ht side natural to many persons, is such that it is not safe to pronounce positively any amount, within the limits which small disseminated tubercles are competent to produce, to be morbid when it is

lous deposit in the left lung, the vocal resonance
on the right side. The fact, therefore, that the
exaggerated on the left side does not militate again
tuberculous disease on that side.

A bronchial *souffle* or puff accompanying whispe
included among the vocal phenomena indicating in
lung from tuberculous deposit. A bellow's-sound, m
and high in pitch, existing within a limited space
the chest on one side, and especially on the left
sign in the diagnosis of tuberculosis. Analogous
and mechanism to the high-pitched intense expirat
bronchial and the broncho-vesicular respiration, it
in cases in which the signs just mentioned are obscu
This sign is presented in a more marked degree i
an abundant tuberculous deposit, but in cases of s
tubercles a *souffle* may be discovered on the affect
absent on the opposite side, or, if present on both
intensity and the elevation of pitch on one side con
characters. It is a more significant sign if it exis
because it is found in some persons more developed
right side as a normal disparity.

Directing attention now to the phenomena furnish
when the tuberculous deposit is abundant, and the
to a greater or less extent solidified, the respirator
sent still the broncho-vesicular modification, mo
before, or more or less of the elements of the bro

an an increase of the intensity. Of 38 examinations in different
ses in which the facts pertaining to this point were noted, the
umber of instances in which there was diminution on the side most
fected is 26, while the intensity was greater than on the opposite
de in 12. The diminution in different cases varies much in degree.
several instances among the cases just referred to, the sound was
feeble as to be scarcely appreciable, and it was difficult to study
characters aside from the intensity. The characters, under these
rcumstances, are those which belong either to the broncho-vesicular
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with a small amount of tuberculous disease all these characters are observed, but oftener more or less of them are wanting. The presence of certain of the broncho-vesicular elements, and the absence of others, give rise to considerable diversity in different cases. These diversities it will be useful to study with a little detail. It is needless to remark that in determining the existence and the characters of abnormal modifications of the respiration, auscultation is to be practised at the summit of the chest on both sides, and the phenomena carefully compared. On the side affected, the intensity of the respiratory sound may be either increased or diminished. It is much oftener diminished,[1] but when it is not too feeble to be distinctly heard, if the lessened intensity be due to increased density of lung, produced by tuberculous disease, it is always altered in other particulars; in other words, more or less of the broncho-vesicular characters are added, these characters being independent of the intensity of the sound. The fact just stated will serve to distinguish the feeble respiration due to tuberculous disease from that incident to simple emphysema. Occasionally the inspiratory sound is inappreciable, unless Cammann's stethoscope be employed. On the other hand, the inspiratory sound may be alone heard, *i. e.* without any sound of expiration. The abnormal modifications will then consist of shortened duration, diminished vesicular or acquired tubularity of quality, and elevation of pitch, pertaining, of course, exclusively to the inspiration. These three characters go together. The variation in pitch is frequently the character most readily recognized. *Rudeness*, *harshness*, and *dryness* of the sound, pertain to this character together with the tubularity. These three characters are shown by contrast with the longer duration, the more marked vesicular quality, and the comparative lowness of pitch, which belong to the inspiratory sound on the opposite side, or over the middle and lower third of the chest on the same side. If an expiratory sound be present, it is often, if not generally, more intense than the sound of inspiration. Its intensity, however, varies. More or less prolonged, its duration differs in different cases. It is uniformly higher in pitch than the inspiratory sound, the disparity being in some cases much more marked than in others. A point of contrast between the two sides of the chest in some instances is the presence of an expiratory sound on one side and not on the other; and if diffused over both sides, its characters are the reverse of those which render it a sign of increased density of lung from tuberculous disease; they are relative shortness of duration, with less intensity and pitch lower than belong to the sound of inspiration. As the expiratory sound is sometimes wanting, so in some instances it is alone present, no sound of inspiration being discoverable. It is not uncommon in cases of tuberculosis to find the following results on comparing the two sides of the chest: on one side a vesicular inspiration, more or less intense, with no expiratory sound, and on the opposite side a prolonged, more or less intense and acute expiration, with a very feeble or scarcely appreciable sound of inspiration.

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[1] Fournet states that increased intensity of the respiratory sound is the first change induced by the deposit of tubercle (op. cit.). My observations lead me to an opposite conclusion, as stated above.

The diversities which different cases present as respects the presence or absence of more or less of the elementary characters of the broncho-vesicular respiration, are not of importance from their possessing respectively any special significance. The simple point practically is to determine the existence of any of the elements of the broncho-vesicular respiration. The broncho-vesicular respiration, in conjunction with other signs and with symptoms, is diagnostic of a tuberculous deposit not producing complete solidification, extending over a considerable space, at or near the apex of the lung. Its availability in diagnosis of course depends on its constancy, and the facility with which it may be recognized. Guided by the impressions derived from my own experience, I should say that cases belonging in the class of small, disseminated tuberculous deposits, are extremely rare in which certain of its elements are not sufficiently marked to be appreciated by one acquainted with the subject, and possessing a fair amount of skill as a practical auscultator.

In comparing the respiratory sounds at the summit of the chest, in front and behind, on the two sides, it is essential, if we would avoid errors, to make due allowance for the points of normal disparity existing in many persons in this part of the chest. These have been considered in the chapter on auscultation, in the first part of this work, to which, in the present connection, the reader is referred. It is to be borne in mind, that on the right side, at the summit, especially in front, the inspiratory sound is frequently less intense, less vesicular, and higher in pitch, than on the left side, and that a prolonged expiration on the right side, occasionally more intense and higher in pitch than the inspiratory sound, and sometimes existing alone, is observed in healthy persons. Hence, the character of the broncho-vesicular respiration should be strongly marked at the summit of the right side, for it to be considered, in itself, as evidence of disease; but, on the other hand, if situated at the summit of the left side, it is much more significant of a morbid condition.

Until the deposit of tuberculous matter becomes abundant, the broncho-vesicular modification of the respiration, in the greater proportion of instances, is limited to one side of the chest. This fact obtains in cases in which there is every reason to suppose that both lungs contain tubercles. In view of the fact that after a tuberculous deposit has taken place in one lung, in a short time the other lung becomes affected, I have often been surprised at finding the respiration over the lung least affected nearly or quite normal. It is true that under these circumstances we have not a healthy lung to serve as a standard of comparison, but without such a comparison, it is practicable to judge of the pitch and vesicular quality of the inspiration, and the relative intensity, duration, and pitch of the expiration, if the latter be present, and thus to determine whether the respiration be broncho-vesicular or not. I can only account for the fact now referred to, by supposing that when the increased density at the summit of one lung is sufficient to occasion a distinct modification of the respiratory sound, the activity of the other lung is sufficiently increased for the normal characters to be maintained, notwithstanding the presence of a certain number of tubercles, without giving rise necessarily to a well-marked exaggerated respiration. A well-marked exaggerated respiration, as will be presently noticed, does occur in the opposite lung in some instances, in which the amount of tuberculous deposit is considerable on one side.

Interrupted, wavy, or jerking respiration, is a modification occurring in a certain proportion of cases of small tuberculous deposit, but also observed occasionally when other signs and the symptoms do not denote tuberculous disease. Its value as a diagnostic sign, therefore, depends on its being associated with other evidence of tuberculosis. In the 22 examinations in cases of small, disseminated tubercles, among the 100 analyzed, this sign was observed in two.

Of adventitious sounds or rales, the crepitant, dry crackling, crumpling, the sub-crepitant, and the other bronchial rales, moist and dry, particularly the latter, are all occasionally observed in cases of tuberculosis. They do not indicate the disease directly, but, on the contrary, if we except dry crackling and crumpling, they are the signs generally of other morbid conditions. Indirectly, they become significant of a tuberculous affection when they occur under circumstances which warrant the inference that the particular morbid conditions which they immediately represent involve the coexistence of tubercles. Their relation to the disease, as already remarked, is therefore contingent or accidental.

A veritable, well-defined crepitant rale denotes pneumonitis in the vast majority of cases. Pneumonitis, occurring between the extremes of life, if it be circumscribed, *i. e.* extending over a portion only of a lobe, and situated at or near the apex of the lung, is highly significant of tuberculosis, because, in the first place, under these circumstances it is not primary, since primary pneumonitis extends over a whole lobe, and affects by preference the inferior lobe; and, in the second place, observations show that circumscribed pneumonitis is occasionally developed in the vicinity of tuberculous deposits, viz., at or near the apex of the lung. A crepitant rale is thus inferentially a diagnostic sign of tuberculosis when it is found at the summit of the chest, extending over a limited area. As respects the frequency of the occurrence of circumscribed pneumonitis, in connection with tuberculous disease, and the consequent frequency with which a crepitant rale well-marked (in distinction from dry crackling) becomes a sign of the latter affection, my experience accords with that of Dr. Walshe, viz., the coincidence is rare. It is not, however, less significant on this account when it does take place.

Dry crackling, as distinguished from a well-marked crepitant rale, consists of a few crepitations, apparently reaching the ear from a distance, generally confined to the end of the inspiratory act. Whatever opinion may be entertained of the mechanism of its production, observations show that it frequently occurs in the early stage of tuberculosis, and is rarely observed, at the summit of the chest, except there exist a tuberculous affection. Hence it possesses a certain degree of significance, especially when associated with other signs and with symptoms having a similar diagnostic bearing. Of the 22 examinations in cases presumed to be of small disseminated tubercles, it was noted in 9. In several instances it existed at the summit of the chest on both sides, but was more marked on the side which the associated signs indicated as the seat of the deposit.

The same remarks are applicable to a crumpling sound, except that the latter is much less frequently observed in cases of tuberculosis. For all practical purposes it suffices to consider this as a variety of crackling.

A sub-crepitant rale is occasionally developed in proximity to tubercles, proceeding either from the presence of liquid matter escaping from the cells into the smaller bronchial tubes, or produced within the tubes as the result of circumscribed capillary bronchitis. In either case its situation at the summit of the chest, and the limited space in which it is heard, are the conditions under which it is significant of tuberculosis.

The occasional development of bronchitis, not only in the smaller but the larger tubes in the vicinity of tubercles, is an event belonging to the natural history of pulmonary tuberculosis. Hence, the production of sibilant, sonorous, and mucous rales. These rales represent morbid conditions pertaining to bronchitis; but bronchitis limited to the upper portion of the lungs, and especially confined to one side, is not a primary affection. These restrictions conflict with the laws of primary bronchitis, which is one of the symmetrical diseases, and extends over the bronchial tubes distributed to the lower as well as the upper lobes. The physical signs of primary bronchitis, as has been seen, are especially manifested, not in front at the summit, but over the middle and lower portions of the chest behind. Hence, when confined to the summit, and especially to one side, the bronchitis is secondary, and in this situation the probabilities are greatly in favor of its being induced by tuberculous disease.[1]

Moist crackling or mucous rales may, however, be produced by the escape of softened tuberculous matter into the tubes without necessarily involving the coexistence of circumscribed bronchitis. The development of moist or bubbling sounds is generally regarded as a circumstance distinctive of the fact that softening has taken place. Undue significance, as it seems to me, has been attached to this circumstance. It is impossible to determine from the characters of the sounds whether they proceed from the presence of softened tuberculous matter, or from mucous secretions, or (as must be the case frequently) from both combined. And inasmuch as circumscribed bronchitis may undoubtedly exist before softening of the tuberculous matter ensues, mucous rales are heard before the disease has advanced to this stage. Not indicating necessarily softening, moist rales limited to the summit of the chest are highly diagnostic of tuberculosis, and in cases of doubt it is useful to auscultate repeatedly, and especially in the morning before expectoration has taken place, in order to discover them, if they exist.

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[1] A clicking sound has been supposed to be specially significant of the existence of tubercles. It is so, however, solely for the reasons which invest other bronchial rales with this significance. There are no grounds for regarding the character of the sound as distinctive. A clicking sound is heard in primary as well as secondary bronchitis.

It thus appears that with respect to all the adventitious sounds or rales just noticed, their diagnostic value in cases of tuberculosis depends on their being limited to a circumscribed space at the summit of the chest. Their value is enhanced by association with other phenomena, physical and vital, pointing to tuberculous disease. They are occasionally, not constantly, present in cases of tuberculosis. They cannot, therefore, be relied upon in the diagnosis; and, as already remarked, although of importance when present, we cannot argue against the existence of tuberculous disease from their absence. As criteria of the disease, they are much less important than the phenomena included under the title of the broncho-vesicular respiration.

An abnormal transmission of the heart-sounds, oftener observed and more marked in cases of abundant tuberculous deposits, may be a sign of some value when the affection consists of small disseminated tubercles. If the sounds of the heart are heard with equal, if not greater distinctness, at the summit of the right as of the left side, it is a point the more worthy of attention from the difficulty of determining, in some instances, whether the characters of the broncho-vesicular respiration on the right side are due to a morbid source, or merely to a natural disparity. This difficulty, which is an obstacle in the way of the diagnosis when the tuberculous affection is seated in the right lung, renders the collateral evidence of the disease in this situation of greater practical value than when the left lung is affected. It is chiefly with reference to the detection of tuberculosis on the right side that this sign is useful; and, obviously, it is a sign more available on the right, than on the left side.

Passing next to the auscultatory phenomena produced by the voice, an exaggerated vocal resonance is an important physical sign of tuberculosis when it exists at the summit of the chest on the left side. On the other hand, a relatively greater degree of resonance on the right side, in itself, has little or no diagnostic importance. This difference is owing to the normal disparity found in most persons, especially in front. The greater intensity of vocal resonance on the right side natural to many persons, is such that it is not safe to pronounce positively any amount, within the limits which small disseminated tubercles are competent to produce, to be morbid when it is observed on this side. If, however, a greatly exaggerated resonance on the right side is found in conjunction with other signs existing on this side which point to tuberculosis, it derives some weight from the association. The fact of the disparity between the two sides so often existing in health, renders an exaggerated resonance on the left side doubly significant. It is entitled to great weight in the diagnosis. It is frequently the case, however, that notwithstanding a tuberculous deposit in the left lung, the vocal resonance continues greater on the right side. The fact, therefore, that the resonance is not exaggerated on the left side does not militate against the existence of tuberculous disease on that side.

A bronchial *souffle* or puff accompanying whispered words is to be included among the vocal phenomena indicating increased density of lung from tuberculous deposit. A bellow's-sound, more or less intense and high in pitch, existing within a limited space of the summit of the chest on one side, and especially on the left side, is a valuable sign in the diagnosis of tuberculosis. Analogous in its character and mechanism to the high-pitched intense expiratory sound in the bronchial and the broncho-vesicular respiration, it may be developed in cases in which the signs just mentioned are obscure or even absent. This sign is presented in a more marked degree in connection with an abundant tuberculous deposit, but in cases of small disseminated tubercles a *souffle* may be discovered on the affected side when it is absent on the opposite side, or, if present on both sides, the greater intensity and the elevation of pitch on one side constitute the morbid characters. It is a more significant sign if it exist on the left side, because it is found in some persons more developed and acute on the right side as a normal disparity.

Directing attention now to the phenomena furnished by auscultation when the tuberculous deposit is abundant, and the lung near its apex to a greater or less extent solidified, the respiratory sound may present still the broncho-vesicular modification, more marked than before, or more or less of the elements of the bronchial respiration may be strongly marked, or the respiratory sound may be suppressed.

Suppression of the respiratory sound over tuberculous solidification, is rarely observed at the summit of the chest in front. It occurs oftener, but by no means frequently, over the scapula. It is noted in but 5 of 62 examinations. Diminished intensity of the respiratory sound, however, is a frequent modification. It occurs much oftener than an increase of the intensity. Of 38 examinations in different cases in which the facts pertaining to this point were noted, the number of instances in which there was diminution on the side most affected is 26, while the intensity was greater than on the opposite side in 12. The diminution in different cases varies much in degree. In several instances among the cases just referred to, the sound was so feeble as to be scarcely appreciable, and it was difficult to study its characters aside from the intensity. The characters, under these circumstances, are those which belong either to the broncho-vesicular or to the bronchial respiration. Occasionally tuberculous solidification gives rise to a bronchial respiration, with all its characters as intense as in the cases of pneumonitis in which it is most strongly marked,—the inspiration loud, tubular, high in pitch, followed, after a brief interval, by an expiratory sound, prolonged, higher in pitch, and more intense than the sound of expiration. Thus complete, it occurs in but a certain proportion of cases. Usually a portion only of the elements of the bronchial respiration are present. An inspiratory sound may alone be heard, which, if bronchial, is purely tubular, *i. e.* devoid of any vesicular quality. Less frequently an expiratory sound is alone heard, which is more or less prolonged, high in pitch, sometimes loud and near the ear; in other instances faint and distant. These diversities, when the quantity of tuberculous deposit is abundant, as well as when it is small, do not denote any special pathological distinctions. The practical point is simply to determine the fact of the existence of more or less of the elements of the bronchial respiration. With an equal amount of disease, owing to differences in the disposition of the tuberculous matter, the bronchial respiration in one case may be intense and complete, and in another case comparatively feeble and imperfect. The most strongly marked bronchial respiration may only show that the solidification, in its relations to the larger bronchial tubes and the surface of the lung, is disposed in a manner most favorable for the development and transmission of the sound.

In cases of considerable tuberculous solidification at the summit of one lung, a deposit more or less in amount exists at the same time in the other lung. Auscultation on the side opposite to that most affected, may discover the characters of the broncho-vesicular or the bronchial respiration more or less marked. An obvious disparity between the two sides is usually apparent; but it is occasionally somewhat difficult, by the combined results of percussion and auscultation, to determine on which side the disease is most advanced. This difficulty, however, very rarely exists if the disease has not advanced to excavation, and, under the latter circumstances, is not often experienced. On the other hand, while the physical evidence of extensive tuberculous solidification on one side exists in some instances, on the opposite side the vesicular murmur apparently retains its normal characters. In such cases the respiration on the side least affected is supplementarily exaggerated; and this abnormal development of the vesicular murmur prevents those modifications from being manifested which would be observed with the same amount of disease, if the other lung were not affected.

Adventitious sounds, or rales, are frequently heard in auscultating patients with abundant tuberculous deposit. Including friction-sounds, they are noted in 25 of 62 recorded examinations, made in different cases. The rales noted in these examinations are either the crepitant or sub-crepitant (the record, sometimes only stating crepitation) in 6; dry crackling, in 3; sonorous, in 5; sibilant, in 6; a clicking sound in 3; a mucous or bubbling sound in 2. Interrupted respiration is also observed in a certain proportion of cases in which the quantity of tubercle is abundant. It is noted in 5 of 62 examinations. But in three of these five instances it was observed on the side opposite to that most affected,—a fact going to illustrate the relation of this sign to a small, rather than an abundant, deposition of tubercle. The rales have the same significance as at a prior date, when the quantity of tubercle is small. The modified respiratory sounds, being more constant, are in a diagnostic point of view of much more importance. The latter becoming generally more marked as tuberculous solidification is induced, the rales are of less value than at an earlier period in the disease, when the deviations from the character of the normal respiration are not so apparent, and the diagnosis accordingly more difficult.

A friction-sound may accompany a tuberculous deposit small in amount. Instances are referred to in the first part of this work in which this sign was due to the pulmonary pleural surface becoming roughened by the projection of numerous isolated miliary tubercles, deposited immediately beneath it. This is an accidental circumstance of very rare occurrence. When the sign occurs it is significant, generally, of circumscribed dry pleuritis over the tuberculous deposits. While the quantity of tuberculous matter is small, it is extremely rare for a friction-sound to be developed; nor is it by any means a frequent sign of abundant tubercle. Although circumscribed pleuritis is so constant an event in the history of tuberculosis, the superior costal movements probably do not involve sufficient attrition of the roughened surfaces to give rise to an appreciable sound; and, moreover, adhesion doubtless speedily follows the fibrinous exudation. This sign was noted in 2 of 62 cases of abundant tuberculous deposit. In both these cases the patients were females, and it is probably true that a friction-sound at the summit of the chest is oftener met with in females, owing to the predominance in them of the superior costal type of respiration.[1]

In cases of tuberculous solidification on the right side, the sounds of the heart are found to be unduly audible in a large proportion of the cases in which the attention is directed to this point. Like the other contingent phenomena, however, this sign is of less importance than at an earlier period, when the physical evidence of the disease derived from percussion and the modified respiration is less clear and positive.

An arterial bellow's-murmur, in the infra or post-clavicular region, is a physical sign occasionally observed, probably due to pressure of a mass of tubercle on the subclavian artery. This sign has not infrequently attracted my attention. When present on one side, and not on the other, and especially on the side presenting other phenomena indicating tuberculous disease, it is to be included in the list of contingent signs which concur to confirm the diagnosis. If it exist on both sides it may be an anæmic murmur, or attributable to pressure of the stethoscope. As an isolated sign it is entitled to but little consideration.

The vocal phenomena furnished by auscultation are more uniformly present and much more marked when considerable tuberculous solidification exists, than in cases of small disseminated tubercles. If the right side be the seat of the more abundant deposit (which, so far as my observations go, is true of the larger proportion of cases), the vocal resonance is generally so disproportionately intense, compared with the left side, that there can be no question as to its not being due to the natural disparity existing between the two sides. On the left side the intrinsic evidence of its morbid character is, of course, still more conclusive. But the rule as to an increased vocal resonance is by no means invariable. Exceptions are observed. There may be no appreciable resonance on either side; and with an abundant deposit on one side it may be equal on the two sides. This will be more likely to be observed in cases in which the abundant deposit is seated in the left side; and under these circumstances, the equality of resonance may be evidence of an abnormal increase on the left side, assuming that there existed a natural disparity in favor of the right side. I have observed the vocal resonance to be more marked at the summit of the right side, when other physical signs showed an abundant deposit in the left lung, the resonance on the affected side either not being exaggerated, or not sufficiently so to equal that which naturally existed on the opposite side.

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[1] A friction-sound at the summit of the chest, developed in the course of pulmonary tuberculosis, is always of the grazing variety; never rough or rasping, as at the lower part of the chest in some cases of general pleurisy.

Bronchophony, as distinguished from exaggerated vocal resonance, is observed in a less proportion of cases. Not unfrequently, however, it is strongly marked. I have observed, in connection with a more abundant deposition in the left, than in the right lung, both sides being affected, that the vocal resonance was greater on the left side, while weak bronchophony existed on the right, and not on the left side.

I may repeat here, what has been said already in the chapter on pneumonitis, and in the first part of this work, that when bronchophony exists, it is generally a persistant sign, not disappearing and reappearing at successive examinations, as is assumed by Skoda. It does not sustain any fixed relation to the bronchial respiration. I have in several instances observed strong bronchophony in cases in which a respiratory sound was so feeble as to be scarcely appreciable, and conversely, there may be an intense bronchial respiration without marked bronchophony. This is a discrepancy not easy to reçoncile, if both phenomena are explained by consonance, according to the theory of Skoda.

A bellows-sound accompanies whispered words more uniformly, and is more intense and acute, *cæteris paribus*, in proportion to the abundance of the tuberculous deposit. This sign may be present in a notable degree, when the bronchial respiration, bronchophony, or exaggerated vocal resonance are not strongly marked.

In cases of tuberculous disease advanced to the formation of cavities, more or less solidification of lung remains; and hence, the auscultatory phenomena just described, do not altogether disappear, although they may be diminished, combined with, and to some extent replaced, by other signs. The characteristics which distinguish this period in the clinical history of tuberculosis, consist in the addition of cavernous signs to the phenomena denoting solidification. It suffices, then, to inquire, what are the cavernous signs furnished by auscultation, and to what extent are they available in diagnosis? As regards cavernous respiration, observations directed more especially to the variations in pitch of respiratory sounds, have led me to the conclusion, in opposition to high authority, that the ingress and egress of air, to and from an excavation of an adequate size, under favorable circumstances; may be readily distinguished; that the cavernous and the bronchial respiration are not, so far as audible characters are concerned, identical; and that the normal laryngo-tracheal respiration is the type of the bronchial, but not of the cavernous respiration. The distinctive features of the cavernous respiration have been considered at some length in Part I. It is sufficient to reproduce a simple enumeration of them here. They consist of an inspiratory sound, non-vesicular or blowing, but compared with the bronchial inspiration low in pitch, hollow, more slowly evolved; and of an expiratory sound, if present, lower in pitch than the sound of inspiration. A fair number of observations in which these features of the respiration were localized during life, and found to correspond in their situation with cavities ascertained to exist after death, have led me to entertain the belief, that the existence and seat of excavations may be predicated on the auscultatory characters just mentioned, whenever they are distinctly manifested. But owing to the number of circumstances which must be combined, in order that a cavernous respiration may be developed, it will often happen that when cavities have formed, examinations fail to discover the evidence of their existence. Indeed, it is often only after repeated explorations, made at different times, and conducted with much care and patience, that they are detected. For an account of the method of prosecuting a search for cavities, and of the circumstances upon which the development of the cavernous respiration depends, the reader is referred to that portion of the chapter on Auscultation, in Part I, which is devoted to this subject.

The cavernous respiration, like the bronchial, is by no means always presented, clinically, with the sum of its characters complete. The inspiratory sound may be alone present. Possibly this is true also of the expiration, but I cannot affirm that I have met with an instance. The lowness of pitch, together with the absence of the vesicular quality, are the points of distinction, when, an inspiratory sound being alone heard, the contrast in pitch between this sound and that of the expiration is not available. Owing to the solidification generally surrounding tubercular excavations, the bronchial respiration is frequently present in the immediate vicinity of the cavernous, and by means of this comparison, the characters of the latter are rendered more conspicuous.

If the distinctive features of the cavernous respiration are manifested within a circumscribed space, and the characters of the bronchial respiration surround this space, the localization of an excavation may be made with confidence. The evidence is rendered still more complete, if at different periods of the day the cavernous respiration is found to be sometimes present, and at other times absent, and more especially if, when found to be absent, it is observed to be reproduced after an abundant expectoration. And if over this space a circumscribed tympanitic resonance on percussion is found to coexist with the cavernous respiration, and to disappear when it ceases, the resonance perhaps presenting a metallic or cracked-vessel intonation, nothing more could be desired to strengthen the proof of the seat of a cavity.

In some cases a cavernous respiration is not thus circumscribed, but is more or less diffused over the summit of the chest. The conditions which may be supposed to exist in these cases are either a very large excavation, or numerous cavities, which if they do not communicate, are situated in close proximity to each other, the aggregate amount of excavation being sufficient to cause a predominance of the cavernous over the bronchial characters of the respiratory sound. On the other hand, if cavities exist, which are small in size, and not numerous, the intervening solidification causes a predominance of the bronchial over the cavernous characters, so that, under these circumstances, auscultation fails in discovering the existence of excavations. In auscultating patients with tuberculosis more or less advanced, the cavernous and the bronchial respiration seem to me not infrequently to be combined; in other words, the respiration appears to present the characters of these two modifications mixed, the cavernous predominating in some cases and the bronchial in others. The existence of cavities may be predicated on such a combination, although their size and situation are not determined. This combination might with propriety be styled a *broncho-cavernous respiration*.

An amphoric intonation is probably conclusive, in itself, of the existence of a cavity. This variety of the cavernous respiration is, however, rarely present in tuberculous excavations.

Gurgling, also, when well marked, is sufficient proof that the disease has advanced to excavation; but as the sound is more or less diffused, it does not serve to fix the precise location of the cavity so well as the cavernous characters of the respiration.

A cavernous vocal sign is transmission of speech, *i. e.* articulate words, to the ear applied over the seat of an excavation. Pectoriloquy, however, as this sign is called, is not exclusively a cavernous sign. It occurs, perhaps more frequently, over solidified lung, and, hence, it is occasionally observed over a mass of crude tubercle before the disease has advanced to the formation of cavities. For this reason, and from the fact that it is very rarely discovered where cavities exist, on account of a combination of various contingencies being indispensable to its production, it possesses very little value, clinically, as evidence of an excavation. Circumstances which render it distinctive, as a cavernous sign, are its being limited to a circumscribed space; its occurrence without being associated with marked exaggerated vocal resonance, or strong bronchophony; its intermittency, and its coexistence with cavernous respiration and a tympanitic percussion-resonance (with or without the amphoric or cracked-metal intonation) confined within the same limits. An amphoric resonance, produced by the voice, is a rare vocal phenomenon, which, when present, is, in itself, more distinctive of a cavity than pectoriloquy.

The act of coughing may develope auscultatory phenomena which are highly significant of tubercular excavation. When a cavity of considerable size and superficially situated is empty, the violent expirations incident to coughing occasion, within a circumscribed area, a hollow, blowing sound, sometimes accompanied by a forcible shock against the ear applied to the chest. If the cavity be partially filled with liquid, a loud gurgling or splashing noise is frequently produced. The latter is eminently a cavernous sign.

Finally, the physical sign which is at once a respiratory, vocal, and tussive sign, viz., metallic tinkling, is occasionally produced in connection with a large pulmonary excavation. The conditions for its production are only present when the cavity is extremely large, and when it contains liquid and air in certain relative proportions. It is so rarely incidental to a tuberculous cavity, that it is only interesting in this connection as a clinical curiosity, and as furnishing an exception to the rule, that it denotes perforation of the lung and pneumo-hydrothorax.

In employing auscultation in cases of suspected tuberculosis, the attention is, of course, as in practising percussion, to be directed especially to the summit of the chest, in view of the fact that in the vast majority of cases a tuberculous deposit takes place first and chiefly at or near the apices of the lungs: the occasional exceptions to this law will be hereafter noticed. In auscultating as in percussing the chest for the evidences of tubercle, it is equally important to examine behind, over the scapulæ, as in front. The post-clavicular space is not to be overlooked, provided the physical evidence of the disease be not sufficiently distinct in other situations. The phenomena discovered by auscultation, as well as those developed by percussion, are to be compared on the two sides of the chest, corresponding points being successively explored. The respiratory sounds being examined first on one side and next on the other side, and contrasted with each other, the observer is to decide whether these sounds are equal on both sides. A disparity between the two sides (making due allowance for certain natural differences) indicates disease. The sounds on both sides may be abnormal, but a law of tuberculosis determines almost invariably the evidences of a greater amount of disease on one side than on the other. Having discovered that a morbid disparity exists, the next step is to analyze the sounds on each side, and ascertain the characters which are morbidly presented. These elementary characters relate to the intensity, quality, pitch, duration, and rhythmical succession of the inspiration and the expiration. After such an analysis we refer morbid alterations to their appropriate place in the catalogue of physical signs: in other words, we determine whether there be present a broncho-vesicular, a bronchial, or a cavernous respiration. The coexistence or the absence of adventitious sounds, or rales, are at the same time ascertained. It is frequently useful to compare the phenomena found not only in corresponding points on opposite sides, but in different portions of the same side. For example, the respiratory sounds over the scapula, above and below the spinous ridge, may present striking points of contrast; as, also, the post-clavicular and the infra-clavicular regions in front, and different parts of the latter region. The upper third of the chest may be compared with the middle and lower thirds, in order to judge by contrast with respect to morbid changes. The chest-sounds may be brought into comparison with the laryngo-tracheal, when it is desired to compare the former with the type of the bronchial respiration. Similar comparisons are to be instituted with respect to vocal phenomena.

The different methods of auscultation have been sufficiently considered in the first part of this work; but I avail myself of this opportunity to bear testimony to the value of the stethoscope recently introduced by Dr. Cammann. Since the chapter on Auscultation, in Part I, was written, several months have elapsed, and in the mean time I have been in the habit of using this instrument more or less, almost daily. In cases of suspected tuberculosis, in which tuberculous deposits are either wanting, or are small and disseminated, by means of this stethoscope a closer comparison of the respiratory sounds can be made than with the ordinary cylinder or the naked ear. A disparity, therefore, on the one hand, is in some instances rendered appreciable which otherwise would not be discovered; and, on the other hand, the absence of a disparity, and the completeness of the normal characters, are more satisfactorily determined than is always practicable without this improved means of auscultatory exploration. It enables the auscultator to study the characters of the respiration in some cases in which it is so feeble as to be with difficulty appreciated by the ordinary cylinder or by immediate auscultation. Its usefulness in cases in which it is desirable to make nice comparisons with respect to vocal phenomena, is not less than in examinations with reference to respiratory sounds. These advantages render the instrument particularly serviceable, both in a positive and negative point of view, in the diagnosis of pulmonary tuberculosis.

Inspection furnishes signs of tubercular disease, consisting of morbid appearances which pertain to the size and form of the summit of the chest, and to the respiratory movements in this situation. Some depression on the affected side, and diminished expansion with inspiration, are apparent in a small proportion of cases, at an early period, when the quantity of tuberculous matter, so far as it can be estimated by means of other signs, is small. A disparity in size and motion, although less frequently observed at this period than subsequently, is of more importance than when the quantity becomes abundant, because the diagnosis, in general, is only difficult so long as the disease has not made much progress. After the deposit has attained to a certain amount, involving considerable solidification, the evidence of its existence derived from the combination of different signs is sufficiently clear and decisive. The obstruction to full expansion of the upper portion of the lung, and the collapse of air-cells produced by a few small disseminated tubercles, may occasion an undue depression either above or below the clavicle, or in both situations, ascertained by comparison of the two sides. Moreover, circumscribed pleuritis, leading to the formation of false membrane, and thereby tending to contract the apex and restrain its expansion, belongs frequently to the early history of tuberculosis, as is evidenced by the symptoms. In comparing the superior costal movements of the two sides, observing the precautions pointed out in Part I, in the chapter on Inspection, the effect of forced as well as tranquil breathing is to be observed. Owing to the limited amount of expansion at the summit of the chest in ordinary breathing, a disparity in males is rarely developed except when the intensity of respiration is increased; and in females, in consequence of the habitual predominance of the superior costal type, a disparity is manifested earlier, more frequently, and in a more marked degree. Mensuration, by means of the graduated inelastic tape, but more especially with the chest-measurer of Dr. Sibson, or the stethometer of Dr. Quain, will show a disparity in expansive motion with greater precision. For clinical purposes, however, inspection suffices. Callipers also enable the explorer to determine, with proper care, the exact amount of variation between the two sides in their antero-posterior diameters. But this exactness, for ordinary practical purposes, has no advantage over the information obtained by the readier and more simple method of comparing with the eye. It is not to be forgotten that a want of symmetry between the two sides, due to curvature of the spine, former pleurisy, or other causes, occasions more or less disparity in size and expansibility, irrespective of present disease; and even when no want of symmetry in the general conformation of the chest is discoverable, a slight difference in the curves of the clavicle may cause the regions above and below this bone to appear on one side relatively somewhat depressed. In making observations on the healthy chest, I have observed that occasionally, even when it appears to be perfectly well formed, there exists a slight disparity in motion at the summit. Isolated from other signs, therefore, variations in size and expansibility, if slight, possess very little diagnostic value. Their importance depends mainly on their connection with other signs, and with symptoms which render probable, if not certain, the conclusion, that they are due to a morbid cause.

At a later period in the progress of the disease, when the tubercular solidification is considerable, and when, as already remarked, the signs furnished by inspection or by mensuration are of less importance in the diagnosis, the depression at the summit and the defective expansion, are generally conspicuous. The cases are few in number in which these signs are wanting. Of 35 recorded examinations, in different cases, in which the appearances on inspection were noted, in all but 4 there was either abnormal flattening, or diminished superior costal motion, or both were combined. The latter was oftener observed than the former, but in the majority of instances depression and deficient expansion coexisted. Depression is generally made apparent by the greater projection of the clavicle, but it is sometimes the case, as remarked by Walshe, that this bone follows the retreating ribs, and then the greater concavity above and the apparent flattening below may be on the side least affected. I have met with instances of this description. In such cases callipers are requisite to demonstrate the side on which exists the real reduction in size.

As would be rationally inferred, a disparity between the two sides, at the summit, in size and expansibility, continues after tuberculosis has advanced to the formation of cavities. It is stated by Walshe that in some cases in which a very large cavity is formed, the depression is less marked than at a prior period, and the expansion movement may be increased. An increase of size under these circumstances would hardly be expected *à priori*, and its occurrence might fairly be distrusted, except it had been positively ascertained by careful comparative measurements at different periods. The increased expansibility is more intelligible. A bulging in the intercostal spaces over a circumscribed space, with the act of coughing, I have in some instances observed, an appearance indicating the site of a large cavity, with its walls situated near the superficies of the lung, and the pleural surfaces adherent.

Palpation may furnish information of some utility in its bearing on the diagnosis of pulmonary tuberculosis. The increased sense of resistance to pressure over tubercular solidification, is ascertained by this method more satisfactorily, than incidentally in the practice of percussion. By placing the hand on the summit, the extent of expansive movement can be estimated, and the two sides compared in this respect. But it is especially with respect to the *vocal fremitus* that this method of exploration is applicable. Its utility in this point of view is comparatively slight. An exaggerated fremitus is an occasional, not a constant, effect of increased density of lung.

Even when solidification is complete and extensive, as it is in some cases of pneumonitis, an appreciable exaggeration of the fremitus is by no means uniform. In the partial and imperfect solidification from tubercle, the sign is often wanting: especially in the early period of tuberculosis, when it is most valuable, it is rarely present. Another reason for the frequent unavailability of this sign is the disparity between the two sides as regards the normal amount of fremitus. It is habitually greater on the right side. Equality in this particular constitutes the exception rather than the rule. This fact renders the sign almost nugatory in cases in which a greater fremitus is found on the right side. Observations show that the fremitus may continue greater on the right side, when other signs indicate unequivocally an abundant tubercular deposit on the left side. But this normal difference between the two sides renders the sign, in some instances in which it exists on the left side, more significant than it would be, were the two sides equal in health. A vocal fremitus existing on the left and not on the right side, or more marked in the former situation, is, in fact, highly significant, but the coexisting signs, under these circumstances, leave no room for doubt as to the fact of solidification of the lung. In accumulating, however, data from every quarter, in order either to render the proof of tuberculous disease perfectly conclusive, or, on the other hand, to exclude the disease, comparison of the two sides as respects vocal fremitus should not be overlooked, although the information, positive and negative, derived from other methods, is vastly more important.

Finally, a succussion-sound, or *splashing*, has been observed when a large tubercular cavity is partially filled with liquid. It is sufficient simply to mention this fact. The sign belongs in the list of phenomena denoting a cavity, but it is so rarely available that the importance of resorting to this method of exploration hardly need be recommended.

Diagnosis.—Pulmonary tuberculosis, although embracing in its career most of the phenomena furnished by the different methods of exploration, has no special pathognomonic physical signs. The phenomena which it embraces belong also to other affections. They represent morbid conditions not peculiar to tuberculosis, but existing in other forms of disease. Isolated from other signs, and dissevered from symptoms, pathological laws, and associated circumstances, none of the physical phenomena which have just been considered would possess marked diagnostic importance. Nevertheless, from their combinations, their conjunction with vital phenomena and with facts pertaining to the natural history of the disease, they acquire a positive value, and are hardly less significant than if they belonged to it exclusively.

These general remarks are alike applicable to the symptoms. The semeiology of pulmonary tuberculosis embraces a series of events which are common to this and other affections, and which, in a diagnostic point of view, derive their importance chiefly from association with each other, from coexisting physical signs, accompanying circumstances, and the laws of the disease.

The diagnosis of pulmonary tuberculosis is based on the positive evidence of its existence. If this evidence is present, we do not call to our aid, save to a very limited extent, the mode of investigation called "reasoning by way of exclusion." The differential diagnosis from other affections hinges mainly on the presence or absence of the signs and symptoms which denote a tuberculous deposit. We do not, in other words, undertake to exclude other affections, but, on the other hand, we direct our investigation to ascertain whether there is sufficient proof of the existence of tuberculosis. Hence it follows, that in order to make the discrimination clinically, and to decide correctly whether a patient be affected with this disease or not, the physician must be acquainted with its symptoms and signs, and understand the conditions under which they constitute positive evidence of its existence. The physical signs have been considered. It remains now to enumerate the symptoms prominently involved in the diagnosis. The latter I shall notice very briefly, limiting the attention exclusively to diagnostic points. And inasmuch as the diagnosis very rarely presents difficulty, except at an early period, before the disease has made much progress, those points which have relation to its development and incipient stage, are chiefly important.

The circumstances, then, which invest the various symptoms attending the development and progress of pulmonary tuberculosis with diagnostic significance are the following. A cough, not originating from a distinct attack of acute bronchitis, and not preceded by coryza, but frequently commencing so imperceptibly that the date of its first appearance cannot be definitely ascertained; in degree slight, moderate, or violent, but persisting for some time with little or no expectoration. Dryness of the cough, continuing for a greater or less period, according to my experience, obtains in a larger ratio of cases than is estimated by Walshe, viz., one-tenth. I should say that careful inquiry of patients will show it to be the rule. An expectoration at first small, transparent, and frothy; becoming gradually more abundant, solid, opaque, yellow, and non-aerated, subsequently consisting of sputa streaked with yellow lines, particolored, and frequently presenting irregular ragged edges; occasionally including small particles resembling boiled rice, and a grumous-looking substance contained in a thinner fluid, like the deposit in barley water. According to Walshe, from whom is borrowed the description of the appearance last named, such a deposit occurs only in cases of phthisis. At a more advanced period purulent matter, in greater or less abundance, running together and forming an ash-colored mass, with a nauseous and occasionally fetid odor. Small fibres, supposed to be exfoliated elastic tissue, discovered by microscopical examination; also detached fragments of other of the anatomical elements of the pulmonary structure, and possibly, in some instances, the tubercular corpuscle. Acute stitch-pains at the summit of the chest, sometimes in front, oftener beneath the scapula; recurring from time to time; at times severe, and lasting for several days; in other instances slight and of brief duration; experienced more frequently on one side than on the other, but often occurring successively, or in alternation, on both sides. These pains generally denote repeated attacks of circumscribed pleuritis. Chills, or shiverings, sometimes observing an approach to periodicity, and liable to be attributed to an irregular or imperfectly developed intermittent. Hæmoptysis,[1] frequently the first symptom to create alarm in the mind of the patient; sometimes preceding other symptoms, and all appreciable physical signs.[2] Increased frequency of the respirations, other things being equal, the increase proportionate to the abundance and rapidity of the tuberculous deposit; want of breath on slight exertion, and in some cases dyspnœa; acceleration of the pulse, not invariably but generally present, and frequently a marked symptom; a vibratory or thrilling character, together with frequency of the pulse, the latter occurring when the tuberculous affection is actively progressing. Nocturnal perspiration, occurring frequently at an early period, as well as when the disease is advanced, in the latter case preceded by febrile movement, and forming an element of hectic paroxysms. Diarrhœa frequently recurring or persisting, denoting intestinal tuberculosis; this complication in some instances developed at an early period, but generally after the pulmonary affection is considerably advanced. Chronic peritonitis, which is very rarely developed, except as the result of tuberculous deposit, consequent to pulmonary tuberculosis, and, therefore, inferentially evidence of the existence of the latter. Chronic laryngitis, which does not precede the pulmonary disease, as was formerly supposed, but indicates a tuberculous affection of the larynx, succeeding the deposit in the lungs, and therefore indicative of the latter. Progressive loss of weight, diminution of the muscular strength, and a marked anæmic aspect, almost invariably accompanying and frequently taking precedence of prominent pulmonary symptoms. Finally, mental buoyancy and freedom from apprehension on the score of disease. This list might be extended, by the addition of symptomatic characters incident to a period of the disease when the diagnosis is rendered sufficiently easy by obvious symptoms as well as by physical signs.

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[1] The subject of hæmoptysis in its relation to tuberculosis, has been elaborately investigated by Dr. Walshe; vide British and Foreign Medico-Chir. Review, January, 1849.

[2] In 91 of the 100 cases which I have analyzed, as respects physical signs, the histories contain information concerning hæmoptysis. It had occurred in 53 cases prior to the time of my examinations. Of 22 cases of small tubercular deposits, it had occurred in 13. Of 11 cases in which the existence of cavities was ascertained, it had occurred in 6. Of 58 cases of abundant deposit, it had occurred in 34.

In a case in which are combined the greater part of the diagnostic points just enumerated, there would be very little room for doubt that the patient was affected with pulmonary tuberculosis. Physical exploration, however, would at once supply additional points, giving to the evidence of the existence of the disease nearly the force of demonstration. The physical phenomena would consist of those denoting increased density or solidification of lung, on the summit of the chest, on one or both sides, with perhaps the addition of the signs of cavities. If, in a case such as is now supposed, presenting a collection of symptoms indicating, with a high degree of probability, tuberculosis, this disease really exists, the physical evidence of its existence is almost invariably positive and easily discovered. But cases frequently present themselves in medical practice in which the diagnostic symptoms are less marked. For example, in conjunction with cough, which is perhaps slight, or, in itself, insignificant, together with a morbid aspect, there may be simply a moderate loss of weight and strength, neither being very apparent to the patient, and yet physical exploration may reveal an abundant tuberculous deposit. Without the aid of physical signs in such a case, there is only room for the suspicion of tuberculosis; with their aid, the existence of the disease is determined promptly and in the most positive manner.

To cite another example: a patient may be attacked with hæmoptysis, having previously supposed himself to be in good health. An examination of the chest may fail in detecting any signs of disease. This is the result in a certain proportion of cases. Or, on the other hand, the evidence of a tuberculous deposit may be clear and unequivocal. In either case the information obtained by physical exploration is of immense importance.

As regards the comparative reliability of the diagnostic characters derived from symptoms and from signs, it is to be remarked that many of the former are only occasionally available. This is true of those dependent on tuberculous complications, viz., intestinal, peritoneal, and laryngeal. Hæmoptysis occurs in only a certain proportion of cases, albeit this proportion is large. The loss of weight and strength is not always marked, and may be due to a variety of morbid conditions other than tuberculosis. Chills and pleuritic pains are not constant events, and their significance depends on their being associated with other symptoms. The pulse is not invariably accelerated, and the respirations may not be increased in frequency. The distinctive characters pertaining to the cough and expectoration may be absent, or not readily ascertained. In short, cases of tuberculous disease by no means always offer, even after it has existed for some time, in the symptomatic characters embraced in the previous history and present phenomena, data sufficient for a probable, still less a positive, opinion as to the diagnosis. On the other hand, a tuberculous deposit is rarely so small in amount as not to induce physical changes in the lung, adequate to the production of signs indicating their existence. The fact just stated, is highly important in its bearing on the value of physical exploration in this disease. A tuberculous deposit sufficient to give rise to the symptoms which lead a patient to seek for medical advice, is almost invariably detected without difficulty by careful physical exploration. On this subject, the student or young practitioner is liable to derive an incorrect notion, from the stress which is very properly laid on the symptoms and signs concurring to establish the diagnosis of small disseminated tubercles. That instances do occur in which the evidence derived from symptoms and signs, conjointly, are slight, and the diagnosis is consequently attended with difficulty, must be admitted; but instances of this kind are exceptions to the general rule. Of the cases of suspected tuberculosis which the physician meets with in practice, if the disease really exist, the physical signs, in conjunction with the symptoms, are positive and easily determined in the vast majority.

This opinion is based on a pretty extensive experience for the last ten years. Let the student, or the practitioner who is not accustomed to physical exploration, then, not be repelled by the erroneous idea that the diagnosis of tuberculous disease very often hinges on points so delicate and difficult to be appreciated, as to compel him to rely in most cases on the symptoms alone. This idea, which I know to be common, does injustice to the subject of physical diagnosis.

An important practical question is, how few physical signs, taken in connection with symptoms pointing to tuberculous disease, are sufficient to establish the diagnosis? The physical phenomena incident to a deposit of tubercle by no means always correspond in amount with the diagnostic characters pertaining to the symptoms. A case may present symptomatic circumstances strongly indicating the disease, and the signs be found not to be proportionately marked. On the other hand, it much oftener happens that while the symptoms alone would leave the diagnosis extremely doubtful, the physical evidence is abundantly conclusive. Assuming the existence of certain symptoms which give rise merely to a suspicion of tuberculosis, for instance, a persisting cough, with loss of weight and a pallid complexion, provided the chest be symmetrical, if on examination a distinct dulness, however slight, is discovered at the summit of the left side, in front, or behind, and especially in both situations, together with an obvious modification of the respiratory murmur, consisting in diminished vesicular quality, with elevation of pitch of the inspiration, or in a prolongation with elevation of pitch of the expiratory sound, in short, more or less of the elementary characters of the broncho-vesicular respiration, the diagnosis is rendered nearly if not quite conclusive. The addition of a highly significant symptom, viz., hæmoptysis, and of an equally significant sign in this situation, viz., increased vocal resonance, scarcely leaves any room for doubt. If these same physical phenomena (which it is assumed are slight), are found at the summit of the right side, the evidence is less conclusive. Contingent or accidental signs are then of much more importance, as showing that the disparity is due to a morbid condition, and not to a natural difference between the two sides. A persisting or frequently recurring sibilant rale, a fine mucous or sub-crepitant rale, or dry crackling, limited to the summit, render it altogether probable that the disparity is morbid, and hence, these signs become highly valuable as diagnostic indications. Their value is much less, under the circumstances supposed, on the left side, because they are comparatively superfluous.

Will an amount of physical evidence still less than has just been assumed suffice for the diagnosis? Pertinent to this inquiry it may be stated, as a rule, that the amount of physical evidence required for the diagnosis is small in proportion as the rational evidence is abundant; in other words, if the diagnostic circumstances relating to the history and symptoms tend very strongly to the opinion that tuberculosis exists, fewer and less marked signs are needed, provided, such as they may be, they are distinct and unequivocal in their character. In point of fact, under these circumstances, the physical signs are generally sufficiently numerous and striking. Assuming, however, that in conjunction with certain significant symptomatic characters, the only physical phenomena discovered are of the class which I have distinguished as contingent or accidental, viz., bronchial rales, crepitation, and dry crackling, within a limited area near the apex of the lung, these signs would authorize a highly probable although not a positive diagnosis. But judging from my own experience, I should never expect to find these phenomena persisting or present in a marked degree without, at the same time, discovering disparity in the percussion-resonance and in the respiratory murmur.

Among the circumstances which, in a rational point of view (as distinguished from physical phenomena), are entitled to weight in the diagnosis of pulmonary tuberculosis, hereditary influence may fairly be included. The statistical researches of Walshe appear to lead to the conclusion that this influence may have been overrated. But while we witness, as we do not infrequently, a family of children springing from a tuberculous parentage swept off in succession by this disease, we cannot doubt that it involves in such instances a congenital predisposition.[1] Age is also entitled to consideration, since it is sufficiently established that the development of the disease is much more likely to take place between 20 and 40, than prior or subsequent to these periods of life.[2]

Another important practical question is the following: Does the absence of any apparent disparity between the two sides, no adventitious sounds being discovered, the percussion-resonance remaining clear and vesicular, and the respiratory murmur apparently normal, warrant a positive opinion that tuberculosis does not exist? This question is equivalent to the inquiry, whether a tuberculous deposit may exist in the lungs in a latent form so far as concerns physical signs. In its clinical bearing this question has, in fact, been already virtually answered. I have said, that whenever there are present symptoms warranting a strong suspicion of a tuberculous affection, which in reality does exist, it may be confidently expected that the physical evidence of its existence will be discovered; and, moreover, this evidence will often be found when the symptoms do not strongly indicate the disease. That tuberculous deposit may be so small in quantity and so distributed as not to give rise to appreciable physical signs, I do not doubt. Autopsical examinations of persons dead with different diseases, appear to show that small depositions not infrequently take place, which remain dormant, become obsolete, or pass through their changes on a minute scale, the ulterior morbid condition on which the deposit depends being from some cause arrested. In these cases it is probable that the disease is frequently latent as respects diagnostic symptoms not less than physical signs. At all events, judging from clinical experience, if on careful and repeated explorations, the resonance on percussion and the respiratory murmur are found to be normal and equal on the two sides, no adventitious sounds being present, it is quite safe to consider the patient non-tuberculous. A practitioner will, of course, feel greater positiveness in the negative result of his examinations, in proportion to his confidence in his tact in exploration, and his ability to appreciate and compare physical phenomena. Moreover, he is not bound to commit himself and the art to an unqualified opinion, whatever may be the strength of his private conviction. It is enough that he state the absence of appreciable evidence of the existence of the disease. Discretion is, however, to be exercised in giving more positive assurances, in cases in which the remedial influence of their moral effect is desirable. It seems gratuitous to add that the prudential course just alluded to is the more politic the less the experience of the physician in physical exploration; but it often happens that patients are pronounced free from tuberculosis, when subsequent events show that the hopes and wishes of both patient and physician had much to do in determining this conclusion.

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[1] A remarkable instance of this kind recently came under my notice. In the space of five years 7 children died of phthisis, all between 18 and 23 years of age. They constituted all the children in the family. The mother died of phthisis shortly before the death of the first child, aged 45 years. The disease was developed shortly after confinement, and the child died in infancy. The father is living and in robust health.

[2] Vide statistical researches of M. Lombard. Valleix, op. cit.

The absence of apprehension which characterizes the mental condition of persons affected with tuberculosis, often makes them tardy in seeking medical advice. This is one reason why, in the majority of cases, when patients first feel the need of resorting to a physician, the diagnosis is sufficiently easy. On the other hand, in various affections in which the mind is differently affected, the apprehension of consumption is a source of great anxiety, and it is the dread of this disease which leads patients to desire a physical exploration of the chest. The timidity and agitation which are sometimes manifested during an examination, and the solicitude shown respecting the result, constitute some ground for a presumption that tuberculosis does not exist.

Of the different non-tuberculous patients whose fears of the disease bring them under the cognizance of the physician, a portion suffer from neuralgic pains in the chest, in conjunction with more or less of the numerous ailments sometimes grouped under the title of spinal irritation. This class embraces females in much the larger proportion. They are usually anæmic and affected with uterine disorder of some sort, together with, not infrequently, hysterical symptoms more or less marked. Judging from the rare instances in which, so far as my observations go, tuberculosis is found under these circumstances, I should say that the morbid condition referred to, to say the least, does not involve any predisposition to the disease. It is not common to find well-marked spinal tenderness in tuberculous patients.

Another class consists of dyspeptics. The hypochondriasis which forms so constant and prominent a feature of the affection known as dyspepsia, induces suspicion and sometimes a fixed conviction that phthisis exists, even when there are no pulmonary symptoms whatever. Tuberculosis has been supposed by some distinguished authors to be often preceded and accompanied at its commencement by notable disorder of the digestive function.[1] Such has not been the fact in my experience. I have not observed that dyspeptics are prone to become affected with tuberculous disease; and, conversely, tuberculosis has seemed to me oftener than otherwise to originate without being attended by any marked evidence of gastric disorder. So far, then, from dyspepsia constituting any ground for anticipating that the evidence of tubercles will be discovered, I have come to regard it in an opposite light.

Another class, and for the last few years perhaps the most numerous, is composed of persons affected with chronic pharyngitis. Chronic pharyngitis is a common affection not only among clergymen, but with persons of different callings. The attention which has of late been directed to it has given it a popular as well as professional prominence;

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[1] Wilson Phillip, Sir James Clarke, and Professor J. Hughes Bennett.

and the idea is generally held that it is a precursor of pulmonary tuberculosis. Moreover, it is often accompanied by more or less cough and expectoration. Having had opportunities of observing numerous cases in which chronic pharyngitis has persisted for years, I am satisfied that so far from the affection tending to tuberculosis, it is rather rare for the latter disease to become developed in this class of patients; and, in fact, I have been led by experience to regard the former as militating against the presumption of the existence of the latter.

Tuberculosis is apt to be suspected during the protracted convalescence from chronic pleurisy, since it is inculcated by most writers that under these circumstances tuberculous disease is very apt to be secondarily developed. Statistical researches show that chronic pleurisy is not, as is commonly supposed, prone to eventuate in phthisis.[1] Tuberculosis, however, does occasionally become developed as a complication, and as a sequel. The diagnosis is attended with difficulty, owing to the fact that the presence of liquid effusion and its permanent effects prevent a comparison of the two sides of the chest. Moreover, chronic pleurisy is apt to be overlooked, and I have known the physical phenomena at the summit of the chest on one side due to the compression by a certain quantity of liquid, attributed to a tuberculous deposit, the presence of the liquid escaping observation from the exploration being limited to the summit. The permanent contraction of the chest, if not great, is also liable to be overlooked, without careful attention, the patient perhaps not being aware that he has ever had chronic pleurisy, or not deeming it important to mention the fact if inquiries are not directed to that point, in endeavoring to determine whether tuberculosis exists, or not; under these circumstances, allowance is to be made for an amount of disparity between the two sides fairly attributable to the past or present pleurisy. The characters of the respiratory sound on the affected side are to be carefully studied. The nearer they approach those found on the opposite side, the less ground is there to suspect a tubercular deposit. This supposes, of course, that the deposit, if it exist, is in the side affected with pleurisy. The remark just made with respect to the respiration will also apply to vocal resonance. The result of an examination of the side not affected with pleurisy is important. Assuming the side first affected to be that in which the pleurisy is or was seated, according to a law of tuberculosis, a deposit will be likely to take place shortly afterward in the other lung; hence, we examine for the physical signs denoting disease of the latter. The contingent phenomena, viz., sibilant, mucous, sub-crepitant rales, and dry crackling, if limited to the summit of the chest on either side, and more especially on the side opposite to that affected with the pleurisy, are highly significant when taken in connection with symptoms pointing to tuberculous disease, such as purulent expectoration, hæmoptysis, and progressive emaciation. The latter are entitled to great weight in the diagnosis. I have known, however, frequent attacks of copious hemorrhage to occur during recovery from chronic pleurisy, and subsequently to recovery, when the other symptoms, the signs, and the issue rendered it probable that tuberculosis did not exist.

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[1] *Vide* Blakiston on Diseases of the Chest, and Essay on Chronic Pleurisy by Author.

The diagnosis of pulmonary tuberculosis being based, as has been stated, on the positive evidence of its existence derived from physical signs and symptoms presented in combination, under circumstances which render them distinctive of the disease, it is unnecessary to dwell on the discrimination from other affections with which it has some features in common. The differential diagnosis, in general, hinges mainly on the answer to this inquiry: Is there adequate positive proof of tuberculosis? If an investigation of the phenomena, vital and physical, develope this proof, the existence of the disease is determined. If the result of the investigation is negative, the diagnosis fails, and, observing proper care and caution, the disease may be excluded. Affections from which it is to be distinguished clinically, in addition to those already referred to in this chapter, are chronic bronchitis, chronic pneumonitis, dilatation of the bronchia, and pulmonary apoplexy. The points involved in the discrimination from these affections, severally, will claim but a few words. With the exception of the affection last named (pulmonary apoplexy), these points have been mentioned in previous chapters.

Chronic bronchitis does not commence with a slight and dry cough, accompanied by an expectoration at first small, transparent, and frothy, and becoming more abundant, solid, and opaque. On the contrary, it generally succeeds the acute form of the disease. Hæmoptysis, pleuritic stitch-pains, chills, progressive marked emaciation, acceleration of the respiration, frequency of the pulse, night perspirations, are events which do not belong to its clinical history. The signs of solidification of the lung and of pulmonary excavations are wanting. The bronchial rales, when present, are observed at the inferior posterior part of the chest, not limited to a situation near the apex, and frequently confined to one side.

Chronic pneumonitis is exceedingly rare. When it occurs, it succeeds acute inflammation. Acute pneumonitis, on the other hand, is rarely followed by a tuberculous deposit. The inferior lobe is the seat of pneumonitis in the great majority of cases, while a tuberculous deposit, commencing in the lower lobe, occurs only as an extremely infrequent exception to a law of the disease. The liability of mistaking tuberculosis for chronic pneumonitis is greater than of taking the latter for the former. This error I have known to be committed. A case may present itself in which the error, for a time, would be very likely to be committed. An hospital patient, somewhat advanced in years, is admitted, with acute pneumonitis affecting the upper lobe. Taking the age into consideration, the situation of the inflammation is not remarkable. The appearance of the patient, and the previous history, which is not obtained at first with minuteness, owing to the inconvenience to the patient to reply to many questions, does not lead to a suspicion of tuberculosis existing prior to the pneumonitis. He passes through the acute disease in a favorable manner, and appears to be rapidly convalescing. Cough and puruloid expectoration continue, and on physical examination, marked dulness, bronchial respiration, and bronchophony, are found to persist, with very little diminution, at the summit of the chest, even after the patient has recovered from the pneumonitis sufficiently to be up and dressed. For a little time these physical signs are supposed to indicate a slow resolution of the inflammatory solidification. Their continuance, however, leads to a more minute investigation of the case, when it is ascertained that cough and expectoration have existed for several years, the patient retaining sufficient strength to labor, and not considering himself much of an invalid. On inquiry, it appears that hæmoptysis has formerly occurred. A careful examination reveals the physical sign of disease at the summit on both sides. Tuberculosis is sufficiently established, and the progress of the case confirms the diagnosis. This is a transcript of the leading circumstances of a case which actually occurred.

Dilatation of the bronchiæ, as has been seen in treating of this lesion, may present the physical signs characteristic both of tuberculous solidification and excavation. The diagnostic points have been fully considered. A simple enumeration of the more important of them will here suffice. The significant symptoms of tuberculosis are wanting, viz., hæmoptysis, notable and progressive emaciation, night perspirations. The situation of the physical signs is less uniformly at the summit of the chest. The percussion-dulness is not proportionate to the intensity of the bronchial respiration; and if cavernous signs exist, they may be accompanied with little or no evidence of solidification surrounding the excavation. These are negative points, which may warrant the exclusion of tuberculous disease. Instances, however, are occasionally met with in which the differential diagnosis is difficult, and, indeed, cannot be made with positiveness. But the infrequency of cases involving doubt is such, that occasions for embarrassment belong among the extraordinary incidents of clinical experience. The period of life when dilatation of the bronchiæ is found to exist sufficiently to simulate phthisis, is usually more advanced than that at which tuberculous disease is most apt to be developed. The age is therefore entitled to some weight in the diagnosis.

It will seldom be a matter of question, whether an existing affection be tuberculosis or pulmonary apoplexy. Yet I speak from personal experience when I say, that to the young auscultator the inquiry may arise under the following circumstances. A person believing himself to be in good health is attacked with copious hæmoptysis. The hemorrhage is not preceded by cough or any apparent pulmonary symptoms. For some months afterward the cough and expectoration are slight. There are no chills, pleuritic pains, nor any of the symptoms significant of phthisis. The average weight is retained. The respirations, when the patient is tranquil, number only 16. The aspect is not morbid; the appetite and digestion good. On physical exploration, marked dulness is found over the upper and middle thirds on the right side; the respiratory sound scarcely appreciable, with no sound of expiration, and vocal resonance moderately greater than on the opposite side. On the left side the percussion-resonance is clear and vesicular; the respiratory murmur appearing normal, except the intensity is increased. The parents are both living and well. Moreover, the patient, who is a young physician, expresses the belief that the dulness on the right side is less than heretofore. These are the prominent points noted in the history of a case, in which, I confess, I was disposed to think sanguineous infiltration had occurred. On examination a few months afterward, the evidence of tuberculous disease was ample, and the patient died with undoubted phthisis.

The diagnosis of pulmonary apoplexy is confessedly obscure; but of this it will be more appropriate to speak in connection with that affection, which will be noticed in the next chapter. I will only remark here, that it probably is a result in the majority of cases, of obstruction incident to heart-disease. This furnishes an important diagnostic point, which is the more significant, because pulmonary tuberculosis is rarely associated with cardiac lesions involving obstruction. Tuberculosis and pulmonary apoplexy may coexist. I have known the latter to supervene upon the former, and destroy life so speedily, that a coroner's inquest was held to determine the cause of death.

In the foregoing remarks under the head of diagnosis, it has been assumed all along that tuberculous disease commences always at or near the apex of the lung on one side, the other side subsequently becoming affected, as a rule; and that the deposit more or less gradually extends from the superior portion downward. Exceptions to the laws of pulmonary tuberculosis just stated occasionally occur. The deposit in a very small proportion of instances commences at or near the base of the lung, and extends upward, thus completely reversing the usual course of the disease. Dr. H. I. Bowditch of Boston, has lately reported eight cases of this kind, in a paper to which reference has been already made in the chapter on Pneumonitis. Dr. Bowditch estimates that these exceptional instances are liable to occur in a ratio of 1 to 150 or 200 cases.[1] The instances observed by him were characterized by a well-marked crepitant rale, behind, over the lower lobe, persisting for weeks or months, followed by the physical signs of solidification, the disease finally extending to the upper lobe, affecting both sides, and advancing to the formation of cavities, as in the ordinary form of tuberculosis. The symptomatic phenomena in these cases did not present any material variation from those usually observed in phthisis. The diagnosis involves discrimination from pneumonitis. The physical signs are common to the two affections, but with this essential difference: in the tuberculous affection the crepitant rale persisted for weeks and months, solidification being slowly induced. Limiting the attention to the physical phenomena, this course bears but a remote analogy to pneumonitis. Moreover, the history and symptoms embrace points which mark the distinction. Symptomatic fever was absent in the majority of the cases after they came under medical cognizance, and the local indications of inflammation. The patients did not lose their strength except gradually in the progress of the disease, as in ordinary phthisis. They were able for a certain period to be up and out of doors. Certain of the symptoms highly significant of tuberculosis were noted, viz., ragged opaque sputa, and in two cases hæmoptysis. The occasional deposition of tubercle primarily at the base of the lung, enforces the importance of not limiting exploration for the physical evidence of the disease to the summit of the chest. When the laws regulating the seat and progress of the deposit are thus reversed, the diagnosis may require some delay and repeated examinations. The physical taken in connection with the symptomatic phenomena will at length furnish sufficient data for a correct opinion.

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[1] Louis found tuberculous disease confined to the lower lobe in 2 of 123 cases.

SUMMARY OF THE PHYSICAL SIGNS BELONGING TO PULMONARY TUBERCULOSIS.

Diminished vesicular resonance on percussion at the summit of the chest, varying in degree from slight dulness to a near approach to flatness; present on one or on both sides, but in the latter case more marked on one side; the dulness, in general, proportionate to the abundance of the tuberculous deposit; increased sonorousness occasionally observed at the summit of the left side, due to transmitted gastric resonance, the sound tympanitic in quality and high in pitch; the vesicular, frequently replaced by a tympanitic sound on either side, when the sonorousness is not increased, constituting tympanitic dulness.

An increased sense of resistance in proportion to the amount of crude tubercle.

A tympanitic resonance over a circumscribed space at the summit, present and absent at different examinations, in some cases presenting an amphoric and the cracked-metal intonation, constituting the evidence afforded by percussion of the existence and situation of tuberculous excavations.

On auscultation, the broncho-vesicular and the bronchial respiration, the latter denoting tuberculous solidification. Frequently, with these modifications, diminished intensity of the respiratory sounds; occasionally suppression of all respiratory sound; interrupted or jerking respiration. Exaggerated vesicular murmur on the side, either healthy or least affected; the crepitant, sub-crepitant, sibilant, or sonorous, mucous, and crackling, or crumpling rales, occurring as contingent signs, their significance dependent on their being found within a circumscribed area at the summit of the chest; abnormal transmission of the heart-sounds, especially at the right summit; increased vocal resonance when situated on the left side at the summit; an acute and more or less intense *souffle*, or bellows' sound, accompanying whispered words, especially if present on the left side; bronchophony, and occasionally transmission of speech, complete or incomplete, over tuberculous solidification; a friction-sound, limited to the summit of the chest.

The cavernous respiration, occasionally observed, alternating with suppression, or gurgling, occasionally amphoric, and, very infrequently, pectoriloquy, constituting the evidence, afforded by auscultating the respiration, of the existence and situation of excavations; the characters of the cavernous and bronchial modifications of the respiration, sometimes combined (broncho-cavernous respiration); splashing, an impulse, seen and felt, existing within a circumscribed space at the summit—signs of cavities furnished by the act of coughing; occasionally, when the cavity is very large, metallic tinkling.

By inspection, flattening, or depression at the summit, either confined to one side, or more marked on one side than on the other; the clavicle generally more prominent, but occasionally receding with the ribs; diminished expansibility with the act of inspiration; the range of motion found to be lessened, as well as size of the chest at the summit, by mensuration.

Disparity at the summit of the chest in vocal fremitus, provided it be found to be greater on the left side.

A splashing succussion-sound in some cases of very large excavation.

ACUTE PHTHISIS.

Pulmonary tuberculosis in the vast majority of instances is eminently a chronic disease. It rarely terminates under several months, and is frequently protracted for a series of years. Occasionally, however, the disease runs a rapid career. In a case observed by Louis, it passed through its different stages, and ended fatally in a month after the occurrence of the first symptoms.[1] A case has fallen under my observation, in which death took place in seventeen days, dating from an hæmoptysis which was immediately followed by grave pulmonary symptoms, the patient at the time of the hemorrhage being apparently in excellent health. A latent tuberculous deposit, however, probably existed previously. A slight hæmoptysis had occurred several months before, and, meanwhile, there existed a little hacking cough, without expectoration, so trifling as not to excite the least apprehension. The pre-existence of a latent tuberculous deposit is perhaps not unusual in cases in which the duration of the disease, as determined by prominent symptoms, is remarkably short. In the exceptional instances in which the disease apparently ends in a few weeks, it is distinguished by the title of acute phthisis. In certain of the cases embraced by this denomination, the affection may not differ in its anatomical characters from ordinary tuberculosis. The only difference is, that the deposit is remarkably abundant and extensive, and passes through its changes with unusual rapidity, softening and excavation taking place within a very short space of time. But the term acute phthisis, is more particularly applied to an accumulation in great numbers of gray semi-transparent granulations, either remaining isolated, or coalescing, and giving rise to a species of infiltration. Restricted to the conditions just mentioned, acute, miliary, or granular phthisis (*phthisie granuleuse*), in the opinion of some pathologists, is essentially a different form of disease from ordinary tuberculosis.[1] The granular deposit affects both lungs, and may be present in both sides, in about an equal proportion, death taking place without softening and excavation.

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[1] Valleix, op. cit.

The diagnosis of the form of disease just referred to (which may be denominated *acute* in distinction from *rapid* as well as *chronic* phthisis), is not unattended by difficulty. The physical signs are less distinctive than in ordinary tuberculosis. Owing to both lungs being simultaneously and in some cases about equally affected, a marked disparity in the percussion-resonance is not always apparent. If the granulations remain isolated, although very numerous, notable dulness is not produced. Auscultation may not furnish morbid phenomena other than are afforded in acute bronchitis, viz., the vibrating and bubbling sounds, inclusive of the sub-crepitant rale. The vocal signs of tuberculous solidification, viz., exaggerated resonance, bronchophony, and fremitus, are wanting. The prominent symptoms attending the progress of the disease, are chills, followed by febrile movement, the pulse becoming rapid, with heat and dryness of the surface; great muscular prostration; notable increase in the frequency of the respirations, with or without a corresponding degree of suffering from want of breath or dyspnœa; lividity of the prolabia; toward the close of the disease quiet delirium; *subsultus tendinum* and incontinence of urine sometimes occurring before death; pains in the chest, which are rarely severe; cough more or less violent, dry, or accompanied by small expectoration which is sometimes slightly bloody; occasionally diarrhœa. Owing to the rapid march of the disease, emaciation is a symptom much less marked than in ordinary tuberculosis.

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[1] M. Robin, Dictionnaire de Médecine, Paris, 1855, art. *Phthisie et granulation.*

The differential diagnosis from other affections offers an exception to the rule stated, with reference to chronic tuberculosis, viz., that it turns mainly on the presence or absence of the positive characters of the tubercular disease. The positive characters of acute phthisis being less distinctive, in discriminating, clinically, between this and other affections, the latter are to be excluded by the absence of their diagnostic traits.

The frequency of the respirations, dyspnœa, lividity, and rapidity of the circulation, might lead to a suspicion of disease of heart. The latter is to be excluded by the absence of the positive physical signs which denote its existence when present.

Pneumonitis is excluded by the absence of signs denoting solidification extending over an entire lobe (in the adult), which is oftener the lower lobe; by the physical phenomena showing the development of disease simultaneously on both sides; the affection not travelling successively from lobe to lobe, and the upper portion of the lung being generally found to be especially affected.

The existence of simple acute bronchitis, either of the ordinary or capillary form, is disproved by a disparity, in a certain proportion of cases, existing between the two sides in the resonance on percussion; by the bronchial rales being less marked, and most manifested at the summit of the chest, instead of over the inferior posterior surface; by a less abundant muco-purulent expectoration; by the dyspnœa and increased frequency of respiration being, on the one hand, much greater than in ordinary acute bronchitis, and, on the other hand, less marked, the immediate danger less imminent, and the career of the disease longer than in acute general capillary bronchitis.

The affection with which acute phthisis is most liable to be confounded is typhoid fever. The latter affection is to be excluded by the absence of its characteristic abdominal symptoms, viz., tympanites, iliac tenderness, gurgling, and diarrhœa. Diarrhœa, however, it is to be borne in mind, is occasionally a prominent symptom during the latter period of acute phthisis, dependent on a tuberculous complication of the intestines. The presence of the typhoid eruption, if well marked, settles the diagnosis; but the absence of the eruption is not proof that the disease is not typhoid fever. The accelerated breathing and dyspnœa of acute phthisis do not belong to the natural history of typhoid fever, except when it becomes complicated with pneumonitis, and this complication is ascertained by means of physical signs. Even with a pneumonic complication, it is extremely rare for the respiration to become embarrassed to the extent which obtains in cases of acute phthisis.

Typhoid fever is farther distinguished by being preceded by a prodromic period, by the earlier occurrence of the peculiar mental condition, as well as its greater prominence, and by the pulmonary symptoms, when present, being developed secondarily, at a period more or less remote from the date of the attack. It is chiefly when cases first come under observation at a late period in the disease, and it is impossible to obtain an account of the previous history from the patient, or others, that the differential diagnosis is attended with real difficulty.

RETROSPECTIVE DIAGNOSIS OF TUBERCULOSIS.

The frequency with which small cretaceous formations, indurations, and puckerings, are found after death in the bodies of persons who have not died from pulmonary disease, renders it probable that a small tuberculous deposit often takes place and is arrested, in consequence either of a limitation inherent in the disease, or from certain influences brought to bear upon it, without advancing through its usual changes, and not producing any serious injury of the pulmonary organs.[1] Clinical observations confirm the correctness of the supposition that an arrest of tuberculosis may take place, the deposit ceasing, the symptomatic evidences of the disease, if present, disappearing, and the patient recovering perfect health. In making examinations of the healthy chest, I have met with instances in which a slight disparity was found in the percussion and respiratory sound at the summit, not attributable to any want of symmetrical conformation, and not in accordance with the laws regulating the normal variations between the two sides. On inquiry, it appeared to be a rational conclusion, that at a former period, these persons had been affected with a small tuberculous deposit. The circumstances which rendered this supposition probable, were certain significant symptoms, such as persisting cough, loss of weight, and in one instance hæmoptysis, which had existed years before, continued for a time, and in the intermediate period the persons had been free from any obvious indications of a pulmonary affection. The physical phenomena in these cases consisted in dulness at the left summit, with feebleness and diminished vesicularity of the respiratory sound. These signs, if slight, in view of the normal disparity frequently existing between the two sides, possess much greater significance as evidence of past, as well as present tuberculous disease, when they are found at the summit of the left side.

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[1] Dr. W. T. Gairdner suggests that the indurations frequently found in the lungs and attributed to tuberculous deposit, are frequently due to collapse of lobules from bronchial obstruction. See Art. in Brit. and For. Med. Chir. Rev., already referred to.

I have also preserved notes of examinations in several cases in which the symptoms and physical signs were considered as indicating unequivocally the existence of tuberculosis, and the patients afterward recovered excellent health, the pulmonary symptoms gradually disappearing. A captious reader might suggest that in some of these instances an error of diagnosis was committed. I am far from professing not to have committed such errors, but in the cases to which I refer, the evidence was quite positive, and of a character not easily mistaken. In some of these cases I have examined the chest after recovery, and found a persisting disparity between the two sides, consisting of comparative dulness on percussion, with relative feebleness, and an approach to the characters of the broncho-vesicular respiration.

Arrested tuberculosis, therefore, is to be included among the conditions giving rise to a permanent disturbance of the symmetry of the chest as respects the phenomena furnished by physical exploration, and not indicating present disease. In view of this fact, it is important, in examinations of the chest which disclose a slight disparity at the summit, more especially if the abnormal modifications are situated on the left side, to inquire into the previous history of the patient, in order to ascertain whether at some former period there did not exist symptoms rendering it probable that there was at that time a tuberculous deposit.

But it is sufficiently established that recovery from tuberculosis may take place after an abundant deposit, and when the disease has advanced to the formation of cavities of considerable size. Gradual contraction and cicatrization of excavations may take place, or they may remain in a stationary and innocuous condition; the tuberculous matter may be quiescent, and probably its complete absorption is not, as has been supposed, impossible.[1] Instances exemplifying recovery from tuberculosis, even when considerably advanced, it may reasonably be hoped, will be of more frequent occurrence than heretofore, in consequence of improved views of the pathology and treatment of the disease. I am acquainted with two persons who have been affected with tuberculosis, as shown by the previous history, one for 21, and the other for 28 years. Both have had repeated hemorrhages, with cough and expectoration, during the periods named, which still continue. But yet both enjoy a tolerable amount of health. It is a curious fact with respect to these cases, that the patients are husband and wife. The husband was tuberculous at the time of his marriage; the affection in the case of the wife became developed subsequently. It is worthy of being added, that in both cases the disease has been allowed to pursue its course with very little medical interference, and both have steadily continued to perform the active duties of life, the husband as a merchant, and the wife as an active superintendent of household affairs.

An illustration of recovery from an abundant tuberculous deposit, and of the subsequent physical signs, is afforded by a case in which I examined the chest, noting the results, five years ago, and an opportunity presented of repeating the examination a few months since. At the first examination, December, 1850, the patient, a female, aged 19, had been affected with the disease for two years, dating from the occurrence of hæmoptysis, which was shortly followed by cough and expectoration. There existed marked dulness at the left summit in front and behind, with diminished expansibility, a feeble bronchial respiration, and weak bronchophony. At the summit of the right side the respiration was broncho-vesicular. The patient after this examination passed from under my observation, and I did not again see her till I was requested to decide on the propriety of her being admitted as a novice into the order of the Sisters of Charity. Her aspect was not morbid. She had a fine complexion, and considered herself well and abundantly able to perform the duties of the religious vocation to which she aspired. She had, however, a slight cough and expectoration chiefly occurring in the morning. The upper third of the left side was notably depressed, the clavicle having also somewhat receded. Dulness on percussion was marked in this situation. The respiration was feeble on the left side, without obvious disparity in pitch or quality. The difference in intensity was marked. A prolonged expiration existed on the left side, the pitch being obscured by a sibilant rale; on the right side an expiratory sound scarcely appreciable. The vocal resonance was notably greater on the left side.

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[1] To consider the processes by which recovery is effected, is not, of course, appropriate in this work. For this the reader is referred to late treatises on tuberculosis, and on the subject of morbid anatomy. I would particularly recommend the late essay on tuberculosis by Prof. J. Hughes Bennett of Edinburgh, for evidence and illustrations of recovery from phthisis. And I avail myself of this opportunity to express my obligations to Prof. B. for the privilege, while in Edinburgh, in 1854, of examining the specimens which are figured in his work.

The subject of arrested tuberculosis and recovery from the disease is one of very great interest and importance, in its relations to pathological inquiries and the management of the disease. It is foreign to the objects of this work to consider it in these aspects. The main purpose of these few remarks, as implied in the heading, has been to illustrate the application of physical exploration in supplying data for a retrospective diagnosis of the disease.

Tuberculosis of the Bronchial Glands—Bronchial Phthisis.

In a large proportion of the cases of pulmonary tuberculosis, the tuberculous affection extends to the bronchial glands. Enlargement of these glands belongs among the varied anatomical conditions represented by the physical phenomena pertaining to the disease, not, however, giving rise to any special signs by which the existence of this complication can be determined during life. But the tuberculosis may be limited to these glands. They may be the seat of a tuberculous deposit involving a considerable increase in size; and by means of processes similar to those which take place in connection with tubercles deposited in the pulmonary structure, cavities may be produced, communicating with the bronchia, occasionally opening into the œsophagus, and sometimes into the pleural cavity. The glands primarily affected are those situated near the bronchi; thence the disease extends to the glands imbedded in the lungs, in the direction of the bronchial subdivisions, and also to those in the neighborhood of the pericardium, the œsophagus, and the large vessels in the anterior mediastinum.[1]

In all these situations the bronchial glands are frequently affected as a complication of ordinary pulmonary tuberculosis, especially in children. It is only when they are the seat of a tuberculous deposit exclusive of pulmonary tubercles, that the disease is properly distinguished as *bronchial phthisis*. Tuberculosis limited to the bronchial glands is a disease peculiar to childhood. With this restriction to early life, it is a rare form of disease, for, if not preceded, it is apt to be followed, by pulmonary tubercles. In a certain proportion of the cases of true bronchial phthisis recovery takes place. This proportion would be larger than it is, except for the liability during the course of the disease to the occurrence of ordinary pulmonary tuberculosis.

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[1] Hasse.

The diagnosis of bronchial phthisis is desirable, especially in view of the fact that the chances of recovery are more than in ordinary tuberculosis; and, on the other hand, it is important to distinguish it from simple bronchitis or pertussis, with which it may be confounded, these affections being attended comparatively with much less danger. In either case the discrimination is attended with difficulty, in part from the obstacles in the way of a satisfactory exploration of the chest in children, and partly because physical signs distinctive of the disease are often wanting. The difficulty of discrimination relates more particularly to the differential diagnosis from ordinary tuberculosis, with which it is so frequently associated.

The disease coexists with either persisting or recurring attacks of bronchitis; the symptoms and signs of the latter affection are therefore likely to be present. The cough is apt to assume a paroxysmal character, resembling that of hooping-cough. Œdema of the face and swelling of the veins of the neck are events occasionally occurring, arising from pressure of the bronchial glands on the vena cava. The respiration is more or less hurried. The loss of flesh is marked, but in this respect, and as regards other symptoms, during the course of the disease remarkable fluctuations are observed.[1] The lymphatic glands of the neck are frequently affected.

As regards physical signs, feebleness or suppression of the respiratory sound on one side is an occasional incidental effect due to pressure of an enlarged gland on one of the bronchi or its larger subdivisions. Dulness on percussion may be apparent in the interscapular regions. The bronchial respiration at or near the situations where it is normally sought for, viz., in the interscapular space behind, and in the neighborhood of the sterno-clavicular junction in front, may be abnormally exaggerated. Mucous rales are more abundant, and possibly gurgling may be observed in the same vicinity. These signs, provided pulmonary tuberculosis be excluded by the absence of the physical evidence of solidification over the chest elsewhere than at the parts just named, taken in connection with the rational evidence of phthisis, viz., persisting cough and emaciation and sometimes perspirations, constitute the data for the diagnosis. Assuming all these data to be available, the diagnosis may be made with much confidence. Even if the positive signs are wanting, if the history and symptoms show that the disease involves something more than bronchitis, and render the existence of phthisis altogether probable, provided the physical signs of pulmonary tuberculosis are also absent, reasoning by exclusion there is good ground for the opinion that the patient is affected with bronchial phthisis. Œdema of the face and swelling of the veins of the neck constitute, in connection with other evidence, a significant indication. Enlargement of the lymphatic glands of the neck is also entitled to weight in the diagnosis.

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[1] Vide West on Diseases of Children, Am. Ed. 1854, p. 287.

CHAPTER VI.

PULMONARY ŒDEMA—GANGRENE OF THE LUNGS—PULMONARY APOPLEXY—CANCER OF THE LUNGS—CANCER IN THE MEDIASTINUM.

THE affections named in the heading of this chapter will complete the list of those which in their anatomical seat have relation to the air-cells or the pulmonary parenchyma. The order in which they are enumerated corresponds to the relative frequency of their occurrence. Collectively they claim a much less extended consideration than has been bestowed on each of the affections belonging in the same group which have constituted the subjects of the three preceding chapters.

PULMONARY ŒDEMA.

The anatomical characters of œdema of the lungs are due to serous effusion taking place, according to Rokitansky, primarily and chiefly within the air-cells, the infiltration, however, extending to the intervesicular areolar tissue. The volume of the affected lung is slightly augmented; it does not collapse or crepitate on pressure. The yellowish limpid fluid which oozes in abundance on section, is usually slightly frothy, showing the access of a small quantity of air to the cells; the texture is solid, resisting, non-elastic, pitting on pressure as in subcutaneous œdema.

Pulmonary œdema, more or less circumscribed, is found very frequently as an anatomical condition incidental to nearly all affections of the lungs which prove fatal. It occurs as a consequence of the hypostatic congestion taking place in the latter part of fevers and various diseases. It may even be a post-mortem event. Developed in conjunction with other pulmonary affections, the phenomena to which it gives rise are so interwoven with those incident to the coexisting morbid conditions, that their recognition is impracticable. It is only as an independent affection, *i. e.* disconnected from other pulmonary diseases, that it is of clinical importance in a diagnostic point of view. As a separate pulmonary disease it is always dependent on some anterior morbid condition. It arises secondarily in the course of organic diseases of the heart accompanied by mitral regurgitation or obstruction, and more rarely, from hypertrophy affecting the right ventricle. It may also proceed from the condition of the blood which, at the same time, gives rise to dropsical effusions in other situations. Hence it is liable to occur in Bright's disease. These pathological relations are important to be borne in mind with reference to the diagnosis. When the serous infiltration takes place rapidly and extensively, as has been sometimes observed, inducing death suddenly, it has been termed serous apoplexy of the lungs. Developed in the course of heart-disease or general dropsy, it is not always either limited to or most marked in the inferior and posterior portions of the lungs on both sides, which is the case when it depends on hypostatic congestion. It may exist on one side only, and be confined to the superior lobe. In a case which recently came under my observation, the œdema occurring in connection with hydro-pericardium, and softening of the heart, moderate serous effusion existing also in the pleura and peritoneum, the upper lobe of the left lung was alone affected.

Physical Signs.—Œdema sufficient in amount and in the extent of lung affected to constitute an important pathological condition, is accompanied by marked dulness on percussion. According to Skoda, the tympanitic quality of sound may be elicited over lung made dense by serous infiltration, as in cases of solidification from inflammatory exudation or tubercle. The resistance of the thoracic wall over the œdematous lung is notably increased.

Owing to the presence of serous liquid in the air-cells and minute bronchial tubes, a sub-crepitant rale is discovered on auscultation. Occasionally, the rale presents all the characters distinctive of the true crepitant, viz., finer than the sub-crepitant, dry, equal, and limited to the inspiratory act. Such instances must be extremely rare exceptions to the rule, that fine bubbling, or the sub-crepitant rale, belongs to this form of disease.

The respiratory sound, when not obscured by the presence of rales, is found to present more or less of the characters of the broncho-vesicular, or the bronchial modifications. The bronchial respiration, however, is never so strongly marked in œdema as in cases of inflammatory or tuberculous solidification, and the high-pitched metallic quality frequently observed in connection with the latter morbid conditions, does not belong to this affection. Great feebleness, and suppression of the respiratory sound, are oftener incident to œdema than to pneumonitis and tuberculosis.

The vocal resonance may or may not be increased. The same remark is applicable to the vocal fremitus. As regards the *souffle* with whispered words, I am unable to offer the results of any observations.

Inspection furnishes negative results.

Diagnosis.—The symptoms belonging to pulmonary œdema offer nothing diagnostic. With more or less cough, and the expectoration of a serous or muco-serous fluid, the respiratory function is compromised in proportion to the degree and extent of the œdema. These are the only symptoms referable to the morbid condition of the lungs; and since the affection occurs as a complication of other diseases, symptoms due to the latter are intermingled. Thus, in the larger proportion of cases, the symptomatic phenomena arising from disease of heart are present, and, in other cases, hydrothorax, together with effusions into other serous cavities, anasarca, &c., dependent on disease of the kidneys.

The positive signs, as has been seen, are dulness on percussion, and a sub-crepitant rale. These signs being present over a portion of the chest, on one or both sides, with or without the characters of the broncho-vesicular or the bronchial respiration, exaggerated vocal resonance and fremitus, and accompanied by more or less acceleration and labor of the respiration, the diagnosis involves, first, their association with diseases in connection with which œdema is known to occur; and, second, the exclusion of other affections in which solidification of lung takes place, more especially pneumonitis, and the hypostatic congestion, or pseudo-pneumonitis, which is incident to the course of fevers, and some other diseases, particularly toward the close of life. If the above-mentioned physical signs become developed in the course of an organic affection of the heart, especially if attended with obstruction to the pulmonary circulation, such as is incident to diseases affecting the mitral orifice, or in conjunction with general dropsy, the occurrence of œdema is established with considerable certainty, provided we are satisfied of the non-existence of the affections to be excluded. The existence of ordinary pneumonitis is rendered improbable by the absence of pain, of the characteristic sputa, of febrile movement, and the physical signs denoting solidification of lung from the deposit of inflammatory exudation, viz., a well-marked and intense bronchial respiration, bronchophony, and the true crepitant rale. The latter sign, however, it is to be borne in mind, may be observed in cases of œdema. Hypostatic congestion, as already stated, involves œdema as an anatomical element. To make the distinction clinically under the circumstances which attend the development of hypostatic congestion, is unimportant. Œdema is most apt to affect the inferior and posterior portions of both lungs simultaneously, but this rule is invariable with respect to hypostatic congestion. The latter condition is, therefore, of course excluded whenever the phenomena denoting œdema are manifested at the superior and anterior portion of the chest.

With hydrothorax, œdema need not be confounded. The change of level of the liquid with the different positions of the patient, suffice to indicate the former. But the two affections may coexist. To determine the fact of this coexistence may not be easy. The presence of the sub-crepitant rale, and the modifications of the respiratory sound due to solidification, viz., the broncho-vesicular or bronchial respiration, superadded to the physical evidence of liquid in the pleura, taken in connection with the existence of general dropsy, may enable the diagnostician to make out this combination. Practically, however, success is not very important.

SUMMARY OF PHYSICAL SIGNS BELONGING TO PULMONARY ŒDEMA.

Absence of vesicular resonance on percussion, with increased parietal resistance; sub-crepitant, and, occasionally, the crepitant rale; broncho-vesicular or the bronchial respiration, never intense or metallic; absence of respiratory sound; increased vocal resonance and fremitus uncertain, and rarely, if ever, present in a marked degree.

Gangrene of the Lungs.

Since the time of Laennec, writers have considered gangrene of the lungs as divisible into two forms, viz., *diffuse* and *circumscribed.* In diffuse gangrene, a considerable extent of lung is affected, generally, the whole or the greater part of a lobe, and the boundaries of the gangrenous portion are not sharply defined. Both varieties are exceedingly rare, but of the cases that occur, those of the diffuse form are vastly less frequent.

Circumscribed gangrene is more limited in extent, and a well-defined line of demarcation separates the affected part from the adjacent pulmonary structure. The gangrenous portion varies in size from that of a bean to a hen's egg. A single portion only may be affected, or the disease may attack several distinct parts. The gangrene leads to sloughing, as in other situations. The decomposed lung-substance, reduced to a dark, greenish, fetid, diffluent mass, is evacuated generally through the bronchial tubes, but occasionally into the pleural cavity. Two instances of the latter have fallen under my observation. It has been known to find its way into the œsophagus, and into the peritoneal cavity. After the evacuation has taken place, an excavation remains, proportionate in size to the extent of the gangrene. In a certain ratio of cases, cicatrization takes place, and a complete cure is effected; or, if the disease do not end fatally, a cavity may remain for an indefinite period. Dr. Gerhard has reported a case in which an excavation was found *post-mortem*, nine years after the date of the disease.

The anatomical conditions which are represented by physical signs are, in the first place, solidification of the pulmonary structure, until the sloughing of the affected portion of lung is accomplished. The extent of the solidification will at least be equal to the size of the gangrenous portion or portions. But it is often more extensive, for, in a certain proportion of cases, the gangrene occurs in the course of pneumonitis, and when not preceded by pneumonitis, inflammatory exudation, and œdema, taking place secondarily, extend to a greater or less distance around the eschar. A cavity, left by the removal of the decomposed portion of lung, constitutes a second anatomical condition. The occurrence of bronchitis, affecting the tubes in proximity to the gangrene, and the presence of liquid in these tubes, also give rise to physical signs.

Circumscribed gangrene is most apt to occur in the inferior lobes oftener situated near the surface, but occasionally deeply seated; on the other hand, diffuse gangrene attacks by preference the upper lobes.

Physical Signs.—The physical signs belonging to gangrene of the lungs are divisible into 1st, those which represent the condition of solidification prior to the separation and removal of the decomposed pulmonary substance; 2d, those due to the circumscribed bronchitis incidental to the disease, and to the presence of liquid in the bronchial tubes; and 3d, those distinctive of an excavation. Inasmuch as the diagnosis of the affection, as will be seen presently, is rarely made prior to the appearance of the gangrenous matter in the expectoration, and, from the insidious manner in which the affection is developed, examinations of the chest often being omitted until the event just mentioned occurs, the phenomena characteristic of this period are determined inferentially, and from isolated cases which have been reported. Deductions based on an analysis of recorded cases are wanting, and this desideratum is the less readily supplied, owing to the great infrequency of the disease. Diminished vesicular resonance on percussion, or dulness more or less marked, will be proportioned to the size of the gangrenous portion of lung, its proximity to the surface, and the extent of superadded solidification from antecedent or consecutive inflammatory exudation, and œdema. When the gangrene occurs as a result of pneumonitis, the dulness will be likely to extend over the space occupied by an entire lobe. But if the gangrene be circumscribed, seated in the interior of a lobe, and the surrounding inflammatory exudation be limited, the percussion-dulness will be confined to a comparatively small area, and may not be discovered even by the most careful exploration. If the affection supervene on an attack of pneumonitis, percussion furnishes no information which could warrant a suspicion that gangrene had taken place; and if the affection be developed without being preceded by the evidence of inflammation of the lungs, the existence of dulness, if discoverable, will be often overlooked, or if discovered may not be attributed to gangrene.

Auscultation in the part of the chest where dulness is found to exist, may furnish the respiratory and vocal signs of solidification, viz., more or less of the elements of the bronchial respiration, and increased vocal resonance, or bronchophony. Rationally considered it would be anticipated that during the decomposing processes leading to softening and diffluence of the gangrenous mass, marked feebleness or extinction of respiratory sound would be a result often observed; and, also, absence of reverberation and transmission of the voice. Bubbling rales, the mucous or sub-crepitant, are heard in the vicinity of the affected part, but they have been observed to extend over a larger space than that corresponding to the gangrenous portion of lung. These rales are due to incidental bronchitis, and at a later period to liquid in the bronchial tubes derived from the excavation. It is possible that a true crepitant rale may be produced by the secondary inflammation of the pulmonary parenchyma surrounding the circumscribed gangrenous portion.

When an excavation has been produced and a bronchial communication established, cavernous signs succeed those due to solidification. The cavernous respiration I have observed well marked in a gangrenous excavation. Gurgling will be heard at variable periods, and sometimes pectoriloquy.

Diagnosis.—The symptoms of gangrene of the lungs, before the matter of expectoration contains portions of the decomposed pulmonary substance, are not distinctive of the affection. In a certain proportion of cases pneumonitis precedes, and the symptoms, of course, are those of the latter affection. Exclusive of these cases, the symptomatic phenomena referable to the lungs are often vague. Cough, with expectoration, denoting bronchitis, may be present, and obscure pains in the chest, accompanied by febrile movement, marked prostration, and general malaise. The disease may be developed without any symptoms which direct attention to the chest. Gangrene of the lungs, in fact, is rarely a purely primary affection. It occurs in the course of fevers, in connection with epilepsy, cerebral affections involving insanity, the effects of intemperance, etc. Illustrations of the several pathological connections just mentioned have come under my observation. The disease is rarely suspected until it is declared by characters of the expectoration which are highly distinctive. A remarkable fetor of the expectoration is the most characteristic trait. The odor is of the peculiar kind called gangrenous, and is similar to that of other moist tissues undergoing decomposition, while in contact with living parts.[1] It is intense, rendering the atmosphere of the apartment frequently almost insupportable. It is generally perceptible in the patient's breath, but is much greater during acts of coughing, even when unaccompanied by expectoration, and, in some instances, is confined to the breath expired in coughing. The matter expectorated is at first of a dirty grayish or greenish color, resembling the diffluent decomposed substance of lung, found in the gangrenous parts after death, in cases in which its removal had not been accomplished during life. Subsequently the expectoration becomes purulent, and the fetor diminishes or may disappear. Even before the eschar has been removed, the fetor is sometimes observed to be intermittent, owing probably to the occurrence of transient obstructions of the bronchial tubes leading to the gangrenous mass. If perforation of the lung ensue, the fetor may diminish or cease.

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[1] The odor is said by Louis and Grisolle to be stercoraceous. It has not appeared to me to have that character in the cases that have come under my observation.

The diagnosis hinges on the distinctive characters pertaining to the breath and expectoration. Without these it would be impossible to determine the existence of gangrene. But a gangrenous fetor is not alone sufficient to establish the diagnosis. This is an occasional symptom in bronchitis, in abscess following pneumonitis, in the cavernous stage of tuberculosis, and in pneumo-hydrothorax. There are, however, certain circumstances connected with this symptom which render it almost pathognomonic of gangrene, and, on the other hand, with due attention to the points involved in the differential diagnosis from the several affections just named, the discrimination is rarely attended with much difficulty. If the expectoration suddenly assume a gangrenous fetor, at the same time becoming copious and presenting the appearances characteristic of decomposed pulmonary substance, the existence of gangrene is quite certain. The diagnosis is rendered still more positive if, prior to the irruption of this peculiar matter, the expectoration, as is sometimes the case, had been slight or altogether wanting. And it is established beyond question if, prior to the characteristic expectoration, the physical evidence of circumscribed solidification had been ascertained, and subsequently the cavernous signs are discovered in the same locality.

In the absence of the circumstances just mentioned, precision of diagnosis is to be based on the exclusion of the other affections in which fetor of the breath and the expectoration is an event of rare occurrence.

Occurring in the course of bronchitis, and due, probably, to sloughing of minute portions of the bronchial mucous membrane, it rarely, if ever, attains to the intensity common in pulmonary gangrene. It is always preceded and accompanied by the symptoms of bronchitis. It is developed less suddenly. The gangrenous matter is not apparent in the expectoration, or, at all events, is less abundant. The physical signs of solidification succeeded by those denoting an excavation are wanting.

An abscess following pneumonitis offers the same physical signs as when gangrene results from that disease. The purulent matter expectorated in the former case is sometimes fetid, but it never has that intense fetor which occurs in the latter case. The contents of a pneumonic abscess do not present the dark, sanious appearance which characterizes liquefied gangrenous lung-substance. On these characters, associated with intense fetor, succeeding an attack of pneumonitis, may be confidently predicated the opinion that gangrene has taken place.

The sloughing of small portions of lung-substance within a tuberculous cavity occasionally communicate a gangrenous odor to the expectoration, very rarely, however, to the extent which obtains in gangrene. But the antecedent history, the present symptoms, and the physical signs at this stage of tuberculosis, sufficiently establish the disease if present; and on the other hand, failure to discover the evidence derived from these sources disproves the existence of the disease if it be not present.

Pneumo-hydrothorax, which, as has been stated, may result from perforation of the pleura in connection with gangrene, is sufficiently evidenced by physical signs, or it is easily excluded by the absence of these signs.

In some very rare instances a superficial gangrenous slough, limited in extent, may escape into the pleural cavity without any communication with the bronchial tubes. This occurred in a case coming under my observation.[1] Under these circumstances the diagnostic symptom, fetor of the breath and expectoration, may be wanting. Acute pleuritis eventuating in pneumo-hydrothorax will be the result, and the prior existence of gangrene may be suspected; but to establish the fact is impossible.

Gangrene of the lungs is to be looked for oftenest in children, next in adults, and last in aged persons.[2] In four of five cases occurring in children which were observed by Boudet, a gangrenous affection was seated in other organs as well as in the lung, and in two cases both lungs were gangrenous. The coexistence of gangrene in other situations is a point of some importance with reference to the diagnosis.

SUMMARY OF PHYSICAL SIGNS BELONGING TO GANGRENE OF THE LUNGS.

Dulness on percussion, varying in degree and extent, unless the gangrenous portion be quite limited, and deeply seated. Bronchial respiration, or suppression of respiratory sound within the area of dulness on percussion; increased vocal resonance or bronchophony and fremitus, occasionally present; mucous or sub-crepitant rales in the vicinity of the gangrenous portion; possibly, a true crepitant rale; subsequent to the occurrence of fetid expectoration, cavernous respiration, gurgling, and in some instances pectoriloquy.

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[1] The case is detailed in Essay on Chronic Pleurisy by the author, page 46.

[2] Dr. Ernest Boudet, in Archives Générales de Médecine, 4 Série, 1843.

PULMONARY APOPLEXY.

Pulmonary apoplexy is a term used to designate extravasation of blood into the parenchyma of the lungs. The term is an unfortunate one, and for the sake of conformity to the nomenclature now in vogue, it is desirable to substitute the word *pneumorrhagia.* Extravasation may take place primarily, either into the air-cells, or into the interlobular and intervesicular areolar tissue, the blood in both cases, unless considerable laceration of the pulmonary structure be produced, coagulating and forming a consolidated mass, resembling, so far as density is concerned, a hepatized portion of lung. The space thus solidified varies in size, frequently being less than a cubic inch, and rarely exceeding four cubic inches. The extravasation may be confined to one spot, or it may occur at several isolated points. In some very rare instances it extends over a whole lobe, and even over the greater part of an entire lung. The limits of solidification are sometimes extended by œdema of the pulmonary substance surrounding the extravasation. Absorption of the effused blood is possible; suppuration may ensue, and an excavation occupy the site of the apoplectic mass; occasionally gangrene results. In some cases the extravasation occasions immediate and considerable laceration of the pulmonary structure, and a cavity is at once formed, containing fluid and coagulated blood, which has been known to be evacuated into the pleural sac.

Apoplectic extravasations are most apt to occur in situations deeply seated in the pulmonary parenchyma, near the roots of the lungs, or in the posterior portion of the lower lobes.

The escape of blood into the bronchial tubes giving rise to hæmoptysis, occurs only when the extravasation takes place, or the blood gains access, into the air-cells. This constitutes the *hæmoptoic infarctus* of Laennec. In the larger proportion of cases of pulmonary apoplexy, hemorrhage manifested externally, in other words, hæmoptysis, does not take place.

Physical Signs.—Dulness on percussion will be marked if the portion of lung solidified be of considerable size and situated near the pulmonary superficies. But if it be small, or if the extravasation occur at several points quite limited in extent, and disseminated, and imbedded beneath the surface of the lung, dulness will be slight or not discoverable.

The development of auscultatory phenomena involves the same conditions. If dulness be appreciable, or marked, the respiration over the site of the extravasation may be found to be suppressed, or to present more or less of the characters belonging to the broncho-vesicular or the bronchial respiration. But if the size and situation of the consolidation are such that no alteration of the percussion-resonance is apparent, it is not probable that any distinct modification of the respiration will be discovered. Exaggerated vocal resonance and fremitus have been observed over an amount of consolidation of blood sufficient to give rise to dulness on percussion.

Mucous and sub-crepitant rales are often heard in the vicinity of the extravasation. Occasionally the true crepitant rale is discovered over or near the situation of the solidified mass.

If an excavation be produced, the cavernous signs may be developed.

Diagnosis.—Very little was known respecting pulmonary extravasations prior to the researches of the illustrious discoverer of auscultation. Laennec supposed that they were always accompanied by hæmoptysis. Subsequent observations have shown that this symptom is present in only a certain proportion of cases, and, also, that of the instances in which hæmoptysis occurs, extravasation into the pulmonary parenchyma coexists in an exceedingly small ratio. It follows that the expectoration of blood cannot be counted on as a diagnostic indication when pulmonary apoplexy actually exists, and that still less is the existence of pulmonary apoplexy to be predicated on the expectoration of blood.

Laennec also entertained the belief that the physical signs of an apoplectic extravasation were quite distinctive. According to him, absence of respiratory sound over a limited area, and the presence of the crepitant rale around the borders of this space, constitute a combination which is diagnostic, provided hæmoptysis be present. Observations, however, have failed to establish the constancy of these associated phenomena. With reference to the crepitant rale in this connection, it is to be borne in mind that the distinction between it and the sub-crepitant, has been made since the time of Laennec.

The diagnosis of pulmonary apoplexy, in fact, can rarely be made with precision, and in many cases is wholly impracticable. The most experienced auscultators concur in the remark made by Bouillaud, that the occurrence of extravasation is rather guessed at than diagnosticated. Aside from hæmoptysis, cough, expectoration, and embarrassment of the respiration, are incident to the affection, but they are not in themselves distinctive, inasmuch as they are incident to other forms of disease. The suddenness with which embarrassed respiration, in connection with hemorrhage and other pulmonary symptoms, is developed, is a circumstance which should give rise to a suspicion of extravasation. A patient attacked at once with these symptoms, having been previously free from all evidence of pulmonary disease, has some affection of rapid development, and this feature is accounted for on the supposition of an apoplectic effusion. Pulmonary apoplexy is very rarely, if ever, a primary affection. It occurs secondarily, in the vast proportion of cases, as a result of disease of heart, consisting in either hypertrophy of the right ventricle, or mitral valvular affection involving obstruction at that orifice. The latter is the lesion with which it is most frequently associated. The symptoms due to the extravasation will therefore be commingled with those proceeding from the heart affection. Its connection with disease of heart, however, is a point to be taken into account in the diagnosis. The presence of signs and symptoms pointing to pulmonary apoplexy derive considerable force from the coexistence of cardiac lesions, especially contraction or patescency of the mitral orifice.

Dulness on percussion over a limited space, situated not at the summit of the chest, and more especially if found on the lateral or posterior surface, together with the auscultatory evidence of solidification, or suppression of respiratory sound, and accompanied by difficulty of respiration suddenly developed, warrants a strong suspicion of extravasation. The sudden development of embarrassed respiration is a point of some significance; but so far as the physical signs are concerned there is nothing in them to distinguish it from the solidification produced by gangrene, œdema, or carcinoma. If hæmoptysis be added, or if the expectoration consist in part of a dark, grumous, bloody liquid, there is ground for a presumption of the existence of pulmonary apoplexy. The non-occurrence of fetid expectoration strengthens this presumption by excluding gangrene. A bloody expectoration may occur equally in carcinoma, but other symptoms and signs denoting carcinoma may be absent so as to render it highly probable that this affection does not exist.

If the physical signs which I have supposed to be present are found at the summit of the chest in front or behind, a tuberculous deposit is vastly more probable than an apoplectic extravasation; and under these circumstances the occurrence of hæmoptysis renders the fact of tuberculosis still more probable. The liability to attribute tuberculous solidification accompanied by hæmoptysis, in certain cases, to pulmonary apoplexy, has been referred to in the chapter on pulmonary tuberculosis. In attempting to make the differential diagnosis from a tuberculous deposit, situation is an important point, observations showing that extravasation is not likely to occur at or near the apices of the lungs, where tubercle is first deposited in the vast majority of cases. The coexistence of heart disease is another point possessing diagnostic significance in this discrimination, since it is rarely found associated with pulmonary tuberculosis.

It is thus seen that considerable uncertainty attends the diagnosis, in cases in which the extravasation is sufficient in amount to give rise to well-marked physical signs. And it is to be borne in mind that in a certain proportion, perhaps the majority of cases, the result of physical exploration is negative. In the absence of physical signs it is in vain to attempt to reach even a probable opinion as to the existence of the affection.

The difficulties in the way of the diagnosis of pulmonary apoplexy render its infrequency a subject for congratulation, irrespective of the danger to life which belongs to it. The diagnosis involves a grave prognosis. In a case which came under my observation, in which it occurred as a complication of tuberculous disease of the lungs, death took place so suddenly as to call for a coroner's inquest.

SUMMARY OF PHYSICAL SIGNS BELONGING TO PULMONARY APOPLEXY.

The evidence of circumscribed solidification, furnished by percussion and auscultation, present in a certain proportion of cases only; moist bronchial rales occasionally observed; cavernous signs succeeding those denoting solidification in some instances.

Cancer of the Lungs.

Notwithstanding the extreme infrequency of cancer of the lungs, the disease possesses practical interest in consequence of the recent investigations of Stokes, Walshe, and others, with reference to its diagnostic characters, which are better established and more reliable than in the instance of the affection last considered. The form of cancer distinguished as encephaloid is that generally present when the lungs are the seat of a malignant disease. Examples of the affection called colloid are exceedingly rare. The morbid deposit is found either in circumscribed masses or nodules, varying from the size of a hazel-nut to that of an orange, more or less numerous, sometimes limited to one lung, but oftener existing in both sides; or, it is infiltrated more or less extensively into the air-cells,[1] giving rise to a condition analogous to hepatization. It is stated that when the disease is primary, the cancerous deposit is infiltrated, and that the nodulated variety occurs when the disease is developed in the pulmonary organs secondarily, *i. e.* subsequent to a deposit in other organs. According to Rokitansky, the latter is met with oftener than the former variety.

In proportion to the cancerous growth the pulmonary structure is destroyed, and the surrounding parenchyma undergoes compression. Solidification, then, is a morbid condition incident to the disease, represented by physical signs. In some cases, softening and elimination through the bronchial tubes of the morbid material ensue, giving rise to the presence of liquid in the tubes, and the formation of cavities. Here are other conditions originating physical signs. In infiltrated cancer the affected lung suffers reduction in volume, and consequent contraction of the chest follows. This variety of the disease is usually limited to one side. The bronchial glands are generally involved. Liquid effusion within the pleural sac not infrequently coexists.

Cancer is very rarely found associated with a tuberculous deposit.

Physical Signs.—If the deposit consist of a few small, disseminated nodules, the intervening parenchyma being healthy, physical exploration may fail in furnishing positive results. If sufficiently large, numerous, or aggregated, and especially if situated near the surface, or if the surrounding lung-substance be œdematous, the phenomena denoting solidification will be more or less marked, viz., percussion—dulness, suppressed or enfeebled respiratory sound, with the characters of the broncho-vesicular or the bronchial respiration, and in some instances increased vocal resonance.

In infiltrated cancer, physical signs are more constant and more marked. The percussion-sound is extremely dull or flat, the vesicular resonance over the middle third being sometimes replaced by tympanitic sonorousness. The dulness may extend beyond the median line on the healthy side. The sense of resistance is notably increased. The respiration is bronchial, and may be either intense or feeble. The respiratory sound is sometimes suppressed. This will occur when the calibre of the bronchus or its larger divisions is diminished by pressure of the cancerous deposit. Increased vocal resonance and bronchophony are observed in a certain proportion of cases. The heart-sounds are unduly transmitted. In short, the physical signs denote complete solidification, which is greater or less in extent. On inspection, flattening or contraction of the affected side is apparent, but not the depression of the shoulder and spinal curvature, which result from chronic pleurisy. The intercostal depressions are somewhat deepened. The respiratory movements are diminished. On palpation, the vocal fremitus may at first be found to be increased, and afterward lessened.

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[1] Rokitansky's Path. Anat. Am. Ed. 1855, vol. 4, p. 100.

If softening and elimination take place, the physical phenomena correspond to the changes in the physical conditions of the affected lung. Percussion elicits more sonorousness, which, however, must be non-vesicular in quality. The sense of resistance is diminished. Mucous rales are now more or less prominent, and the cavernous signs may become developed.

On the healthy side, in cases of infiltrated cancer, or of the nodulated variety, if the latter be extensive, and limited to one lung, the respiratory murmur will be abnormally intense or exaggerated.

Diagnosis.—With reference to the symptoms and signs involved in the diagnosis, it is important to distinguish cancer of the lungs from cancerous tumors situated exterior to the pulmonary organs, generally developed in the mediastinum, which extend into the chest, displacing the lung and other organs. I shall notice the diagnosis of mediastinal tumors under a distinct head. Intra-thoracic cancer, however, may exist simultaneously, both within and exterior to the lungs, and then the phenomena of both will, of course, be combined.

Limiting, at present, the attention to cancer seated within the lungs, in the vast majority of cases, the march of the disease is accompanied by symptoms denoting a grave pulmonary malady, and some of which possess diagnostic significance. A uniform symptom is cough, which is at first dry, but at length is attended by an expectoration more or less abundant, and presenting variable characters. The expectoration consists, for a time, and always in part, of matter furnished by the bronchial mucous membrane. It assumes frequently a purulent appearance, and is sometimes fetid. In a certain proportion of cases, it resembles, according to Stokes, black, and according to Hughes, red currant jelly. This appearance, due to an intimate admixture of blood with the morbid products, is regarded by the observers just named as highly characteristic of the disease. Pure hæmoptysis occurs in a large proportion of cases during the course of the disease; according to Walshe, the ratio being seventy-two per cent.[1] It is possible that the microscopical characters of cancer may be discovered in the sputa. Pain, more or less severe, in the affected side, is a pretty constant and persisting symptom. The pain differs in character in different cases, being acute or lancinating, dull and burning. This symptom is valuable with respect to the diagnosis. The respirations are increased in frequency in proportion to the extent of solidification or destruction, and sometimes, although rarely, dyspnœa becomes a prominent symptom. Dysphagia is a symptom noticed in some cases of pulmonic as well as mediastinal cancer. The pulse, for a considerable period during the progress of the disease, is not notably increased in frequency. Marked febrile movement is rarely present. This is a negative fact of importance in a diagnostic point of view. Emaciation is generally less marked than in most cases of tuberculosis. The complexion, in a certain proportion of cases, denotes anæmia, and may present the waxen or straw-colored hue, which has been considered heretofore as highly significant of malignant disease.

In a small proportion of cases, cancer of the lungs is a latent disease as regards symptoms. And when it is limited to small, circumscribed, disseminated deposits, and especially if these are about equally distributed in both lungs, physical exploration, as already stated, may not furnish positive results. But if the extent of the affected lung be sufficient to give rise to the signs of solidification, which is true of the great majority of the cases of infiltrated cancer, the symptoms and history, taken in connection with the results of exploration, are generally adequate to establish a diagnosis. Under these circumstances, the nature of the disease is ascertained not so much from any positive diagnostic characters, as by excluding other chronic affections also involving solidification of lung, and certain of the symptoms as well as signs which belong to cancer.

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[1] The analysis by Walshe embraced cases of cancer of the mediastina as well as of the lungs.

As remarked by Walshe, infiltrated cancer can only be confounded with diseases lessening the bulk of the lung. These affections, exclusive of cancer, are tuberculosis, chronic pneumonitis, chronic pleurisy, and the affection called by Corrigan cirrhosis of the lung. It will suffice to notice the points involved in the differential diagnosis from these affections respectively.

In pulmonary tuberculosis, the physical signs of solidification, with contraction of the summit of the chest, are equally present; and inasmuch as this affection is as frequent as cancer is rare, the practitioner is very likely to mistake the latter affection for phthisis. Moreover, certain of the symptoms highly characteristic of tuberculosis belong to the history of cancer, viz., hæmoptysis, emaciation, and anæmia. The distinctive circumstances pertaining to both signs and symptoms, are, however, striking. In cancer, the solidification frequently remains for a considerable or even a long period, *i. e.* several months, without material change; in other words, without softening and excavation, as evidenced by the development of mucous rales, gurgling, and the cavernous modification of respiration. On the other hand, with an equal amount of tuberculous deposit, the signs just mentioned would be expected to supervene more uniformly, and after the lapse of a shorter period. And as the softening and elimination of tubercle go on, in general, more extensively as well as more rapidly, these signs become more strongly marked than in the course of cancer. In the latter affection, the phenomena due to the solidification, viz., dulness or flatness, with suppression of respiratory sound, or the bronchial respiration, and perhaps bronchophony, continue without the addition of the contingent adventitious sounds, or rales, for a longer time than in phthisis. In infiltrated cancer, the deposit, being extensive, and, in the majority of cases, limited to one lung, the affection differs from phthisis in presenting the signs of solidification exclusively on one side, the other side affording no evidence of disease. With a similar amount of tubercle in one lung, more or less of the evidences of a tuberculous deposit in the other lung would be expected. The two circumstances just mentioned are the strong points in the differential diagnosis, so far as concerns the physical signs. As regards symptoms, the expectoration of matter resembling currant jelly, which occurs in a certain proportion of the cases of cancer, is foreign to the semeiological history of tuberculosis. Febrile movement, or marked acceleration of the pulse, which, in the majority of cases, characterize the march of phthisis, do not occur till late in the progress of cancer. Pain in the chest, exclusive of that attending the occasional attacks of dry, circumscribed pleurisy, does not belong to the history of phthisis. The pleuritic stitch-pain just referred to, is readily recognized, and constitutes, as has been seen, one of the characteristic symptoms of tuberculous disease. Cancer, on the other hand, generally gives rise to persisting pain, which becomes thus a prominent feature of the disease. The disturbance of the circulation is disproportionately less, compared with the pulmonary symptoms, than in cases of tuberculous disease, the pulse frequently, for a considerable period, remaining nearly or quite natural. Emaciation is not so prominent a feature early in the career of the disease as in the majority of the cases of phthisis. In a certain proportion of cases, cancer of the lungs coexists with a cancerous deposit in some part where its characters are open to inspection or manual examination. The existence of cancer elsewhere than in the lungs, with pulmonary solidification, renders it altogether probable that the latter is cancerous; and if, after the extirpation of a cancerous part, the occurrence of pulmonary symptoms and signs denotes some grave affection of the lungs, the development of cancer in these organs is highly probable, since observations show that, under these circumstances, they are apt to be invaded.

Attention to the foregoing points of distinction will, probably, in a large proportion of cases, enable the practitioner to discriminate clinically between the two affections.

Chronic pneumonitis is nearly if not quite as rare an affection as cancer of the lungs. It is attended by contraction of the chest, but in a less degree than infiltrated cancer. A cancerous deposit differs from tubercle, as has just been seen, in undergoing less uniformly and more slowly the processes of softening and elimination. On the other hand, it differs from chronic pneumonitis in the greater frequency with which it eventuates in excavation. In extensive cancerous solidification, the percussion-dulness sometimes shows the extension of the disease laterally beyond the median line. This does not occur in chronic pneumonitis. Chronic pneumonitis generally succeeds the acute form of the disease. Acute pneumonitis is an antecedent of cancer only as a coincidence. The lower lobe of the lung is most prone to be attacked with inflammation. A cancerous deposit is most apt to take place in the superior lobe. Pure hæmoptysis, which occurs in a large proportion of cases of cancer, very rarely, to say the least, is a symptom of pneumonitis; nor is the jelly-like expectoration distinctive of cancer observed in cases of the latter affection. The concurrence of cancerous deposits elsewhere than in the lungs, has the same diagnostic significance as in the differential diagnosis from tuberculosis.

In chronic pleurisy, marked contraction of the chest follows the absorption of a considerable portion of the liquid effusion. Assuming that a case comes under observation at this period of the disease, there is a possibility of mistaking it for cancer. But, in general, if a case have not been observed, either from the beginning, or an early period in the disease, the previous history will supply facts sufficient, in conjunction with present signs and symptoms, to render the character of the disease abundantly clear. The distinctive circumstances, however, are not less available than in the other affections which are to be excluded in arriving at the diagnosis of cancer. The contraction of the chest is greater and more general on the affected side in chronic pleurisy: the shoulder is depressed, the spine frequently curved in a lateral direction, the intercostal spaces, except at the summit, narrowed, and the respiratory movements more diminished. Unless the liquid effusion be completely absorbed, flatness and absence of respiratory sound extend from the base of the chest upward to a certain height. But it is to be borne in mind that pleurisy, with liquid effusion, may occur as a complication of cancerous disease. The pulmonary and general symptoms are not sufficiently grave for an amount of cancerous disease sufficient to account for the physical signs. Cough and expectoration are frequently slight or wanting in chronic pleurisy. The strength and weight are better preserved. Hæmoptysis occurs but rarely, unless the pleurisy be complicated with tubercle. The jelly-like expectoration peculiar to cancer is never observed.

Cirrhosis of the lung with dilatation of the bronchiæ presents, in connection with thoracic contraction, this distinctive feature of cancer, viz., persistency of the signs of solidification. In the differential diagnosis the existence of the latter affection is determined or disproved by the absence or presence of bloody expectoration and pure hæmoptysis; by pain being either wanting or prominent; by the evidence of a grave affection, which belongs to the history of cancer, derived from loss of weight and strength, and the physiognomy indicating a malignant disease; or, on the other hand, the deficiency of this evidence, which, comparatively speaking, distinguishes cirrhosis, and by the existence or non-existence of cancerous deposit in situations accessible to direct examination.

SUMMARY OF THE PHYSICAL SIGNS BELONGING TO CANCER OF THE LUNGS.

Absence of positive signs, if the cancerous deposit be in the form of small, disseminated nodules, distributed in both lungs. Dulness on percussion with the auscultatory signs of solidification, when the nodules are sufficient in number and size, agglomerated, accompanied by œdema, and especially if limited to or more abundant on one side. In cancerous infiltration, contraction of the chest over the affected lung, and lessened respiratory movement. Marked diminution or absence of vesicular resonance on percussion, with or without the substitution of tympanitic sonorousness, and marked resistance of thoracic wall. Bronchial respiration, or suppression of respiratory sound, with or without increased vocal resonance, or bronchophony, and vocal fremitus. Undue transmission of the heart-sounds. After a time, mucous rales, gurgling and cavernous; the percussion-resonance greater than previously, but tympanitic. Supplementary respiration on the unaffected side.

Cancer in the Mediastinum.

Intrathoracic cancer exterior to the lungs may originate in the pleura or mediastinum, forming one or more tumors, of greater or less size, displacing and compressing the pulmonary organs, the trachea and bronchi, the heart and its large vessels, the œsophagus, thoracic duct, and nerves, and giving rise to symptoms and signs which distinguish it from a cancerous affection, properly speaking, of the pulmonary organs. Although perhaps strictly more appropriate to include cancerous growths exterior to the lungs, in the group of diseases affecting the pleura, which will constitute the subjects of the succeeding chapter, it will be more convenient and useful to notice them in the present connection, in order to present their diagnostic traits in contrast with those which belong to the same disease seated within the pulmonary organs. And it will answer every purpose to notice cancer in the mediastinum exclusively, since, with certain qualifications, which will readily suggest themselves, the points involved in the diagnosis are the same as when the affection is developed at any other point within the chest exterior to the lungs. Moreover, the principles of diagnosis which relate to cancer in the mediastinum will apply, with very few modifications, to other tumors having the same seat; and, therefore, it will suffice to consider the symptoms and signs belonging to the former, as representing the latter, irrespective of certain circumstances distinctive of a cancerous affection, which will be briefly alluded to.

A fact already stated is to be borne in mind, viz., that cancer exists exterior to, and at the same time within the lungs, in a certain proportion of cases.

A cancerous growth originating in the mediastinum, will extend into one or both sides of the chest, in proportion to its magnitude and the direction laterally which it takes. It has been oftener observed to extend into the right than into the left side. In some cases it attains to such size as to fill nearly the entire thoracic space on one side, and also a considerable portion of that on the opposite side. An instance of this kind is given by the late Prof. Swett,[1] in which the tumor weighed eleven and a half pounds. The tumor may extend in either lateral direction about equally, compressing both lungs alike, and giving rise to similar physical phenomena on both sides of the chest.

Physical Signs.—Diminution or abolition of vesicular resonance on percussion extends from the median line on one or both sides over an area within which the tumor is either in contact with or in close proximity to the thoracic parietes. The vesicular resonance, especially at the summit of the chest in front and behind, near the median line, may be replaced by a tympanitic or tubular sonorousness transmitted from the trachea and bronchi. A tympanitic sonorousness may also be found over the middle and lower parts of the chest, and an amphoric modification is sometimes observed. The source of the sonorousness in the latter instance is probably gastric or intestinal. A marked degree of tympanitic sonorousness in either situation is an exceptional phenomenon. As a rule, percussion over the tumor elicits dulness or flatness. And this dulness or flatness being dependent on the presence of a solid mass which is at least attached at the point whence it springs, the area over which it extends remains unaltered, or nearly so, in different positions assumed by the patient. If the tumor extend, so as to come into contact with the heart or liver, the relative positions of the latter to the tumor may frequently be ascertained by an alteration in the percussion-sound. The sense of resistance felt by the finger employed in percussing or in pressure, made expressly with reference to this point, is notably increased.

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[1] Diseases of the Chest, page 335.

Auscultation may discover strongly marked the characters of the bronchial respiration at the summit of the chest in front and behind, extending more or less therefrom over the chest; or these characters may be feebly manifested; or, again, the respiratory sound may be abolished over a greater or less portion of the space in which percussion-dulness or flatness are observed. These variations depend on the relations of the tumor to the trachea and bronchi, and on the amount of compression which may be made on these portions of the air-passages. The bronchial respiration, when present, may be heard either over the compressed lung at the summit, or over the tumor, or in both situations. Its limitations, therefore, as well as those of suppressed respiratory sound, do not always rigidly correspond to the space occupied by the tumor. Adventitious sounds, or rales, are present as contingent phenomena, due to coexisting bronchitis, or, if a cancerous deposit within the lungs have taken place, to its softening and elimination. The sounds of the heart are unduly transmitted.

The vocal signs are variable. There may be marked increase of the vocal resonance and bronchophony, or these phenomena may be wanting. Even pectoriloquy may be present.

Pressure of the tumor on the aorta may occasion an arterial thrill and bellows murmur.

Inspection and palpation furnish important signs. Dilatation of the chest distinguishes cancerous growths developed exterior to the lungs, after they have attained a certain size. The dilatation is partial or extends over the whole of one side, or affects both sides, according to the size and direction of the morbid growth. It may be confined to the sternum and costal cartilages; but as the resistance is less in a lateral direction, the tumor generally extends into the chest, instead of producing a circumscribed enlargement in the situations just mentioned. The intercostal spaces are widened, and in some cases are dilated or even bulging, and remain unaffected by the act of inspiration.[1] The heart may be removed in various directions from its normal position. In the case already referred to, reported by Prof. Swett, it was found to the right of the sternum, where its pulsations had been observed during life. If the tumor extend to the base of the chest, the diaphragm and the subjacent viscera may be depressed. The superficial thoracic veins of the affected side may be enlarged, accompanied with a livid hue and œdematous infiltration. Fluctuation is very rarely observed, but this was present in the case reported by

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[1] Vide case reported by Prof. Swett (op. cit. p. 334), in which bulging was observed.

Prof. Swett. The vocal fremitus over the tumor is abolished. In proportion as the chest is dilated, its contraction with the act of expiration is restrained, and the range of expansive movement correspondingly lessened.

Mensuration shows an increase of the size of the chest; an abnormal disparity in this respect existing between the two sides, if the dilatation be confined to one side, or if the two sides are unequally dilated. This disparity is manifested by semicircular measurements, by a comparison of the antero-posterior diameters, and by a greater distance from the nipple to the median line.

Diagnosis.—The compression and displacement of the pulmonary organs, air-tubes, vessels, œsophagus, etc., by a mediastinal tumor, give rise to a variety of symptoms, as well as signs, which are measurably distinctive when contrasted with cancer of the lungs. In proportion to the extent to which the lungs, air-passages, pulmonary artery, and veins are compressed, the dyspnœa becomes a prominent symptom. The suffering from want of breath, as the tumor increases in size, may be extreme, rendering the recumbent posture insupportable. Pressure on the venous trunks communicating with the veins of the head and upper extremity induces congestion of these parts, which occasions tumefaction, lividity, and œdema. When the pressure is chiefly on the vessels of one side, the distension of the veins, together with tumefaction and œdema, are limited to that side. Heaviness and somnolency are incident to cerebral engorgement. Pressure on the œsophagus may occasion an obstruction to the passage of alimentary substances, and hence results dysphagia, which is more likely to be prominent as a symptom than in cancer seated in the lungs.

Diminishing the calibre of the arteria innominata or the subclavian on one side, the radial pulse of the extremity corresponding to that side may be perceptibly less in size and force than that of the opposite extremity.

If the important nerves, the par vagum, recurrent, or the phrenic, are included in the parts compressed, here is another source of disturbance of the respiration, affecting the diaphragmatic action, and the respiratory movements of the glottis. Hydrothorax or pleurisy leading to the formation of pus (empyema) are contingent affections, giving rise to the phenomena dependent on liquid within the pleural cavity. Pain in the chest is more or less persisting and severe;

cough, hæmoptysis, and the jelly-like expectoration referred to in connection with cancer of the lungs, may occur in the course of this affection, and toward the close of life anasarca is usually present. Perforation of the thoracic wall, of the lung, œsophagus, or some of the large vessels, is liable to occur, giving rise to additional trains of symptoms, or proving the immediate cause of a fatal termination.

Numerous, diversified, and grave as are the results just enumerated, Dr. Walshe states that he has seen them united in one and the same individual.

Differentially, the diagnosis of mediastinal tumors involves, in the first place, a discrimination from cancerous infiltration of the lungs, and the several affections with which the latter is liable to be confounded. The distinctive circumstances are those which have relation to dilatation of the chest, and the pressure of the tumor on the vessels, air-passages, nerves, œsophagus, heart, etc. The phenomena due to enlargement, displacement, and compression, are rarely present, and never to the same extent in cancer seated in the lungs, in chronic pneumonitis, in tuberculosis, or in pleuritis after partial absorption. These phenomena, constituting a large share of the list of symptoms and signs just given, are characteristic of intrathoracic tumor exterior to the lungs. Moreover, from pneumonia, and tuberculosis, and chronic pleuritis, a cancerous tumor in the mediastinum may often be distinguished by the occurrence, in the course of the disease, of certain of the symptoms which are observed in a cancerous affection of the lungs, viz., hæmoptysis, and the currant-jelly expectoration. And in this connection the fact may be again stated, that mediastinal cancer frequently coexists with a cancerous affection of the lungs.

In the second place, mediastinal tumor is to be discriminated from enlargement of heart, pericarditis with large effusion, and aortic aneurism. Many of the phenomena incident to the dilating, compressing, and displacing effects of a mediastinal tumor, which have been enumerated, are common to the affections just named. The differential diagnosis turns on the presence or absence of the symptoms and signs distinctive of these affections; in other words, in arriving at the conclusion that the phenomena proceed from a mediastinal tumor, and not from either of these affections, the latter are to be excluded. To consider the negative points warranting their exclusion, would involve a consideration of their positive diagnostic criteria; for these, the reader must be referred to works which treat of the diseases of the heart and arteries.

In the third place, the affections for which there is the most liability of mediastinal tumor being mistaken, are chronic pleurisy, prior to retraction of the chest, and empyema. Here we have the phenomena due to dilatation, displacement, and in a certain amount to compression, combined. Moreover, the fact is not to be lost sight of, that liquid effusion within the pleural sac, either purulent or serous, may exist as a complication of mediastinal cancer, or of a cancerous affection of the lungs. This complication renders the diagnosis less intricate than might at first be supposed. The phenomena due to compression, viz., dyspnœa, tumefaction of face, lividity, swelling of the veins, dysphagia, are not present to the same extent in chronic pleuritis, or empyema, even when the chest is largely dilated. In a case of mediastinal tumor involving a considerable amount of dilatation of the chest, the effects of pressure on large vessels, trachea, œsophagus, and nerves, may be expected to be in a marked degree greater than when an equal amount of dilatation is caused by pleuritic effusion alone. This is a capital point of distinction. Moreover, the distinctive characters of cancer pertaining to the expectoration, viz., hæmoptysis, and the peculiar jelly-like matter, do not occur in chronic pleurisy or empyema. Hence, if these symptoms are present, they are diagnostic of a cancerous affection; and the coexistence of cancer in some part where the fact can be ascertained by examination, here, as in other instances, is highly significant. Physical exploration furnishes certain distinctive points. The bronchial respiration, and bronchophony are marked in cases of chronic pleuritis with large effusion, or of empyema, only in rare, exceptional instances. Although not uniformly observed in connection with cancer in the mediastinum, they are much more frequently present, and not infrequently strongly marked. The dilatation of the chest from the distension of liquid is more uniform than from an intrathoracic tumor. The intercostal depressions are more constantly and in a more marked degree affected by distension from liquid. It is rare that bulging between the ribs occurs from the distension of a tumor, while it is the usual effect of great enlargement from the presence of liquid. A sense of fluctuation is an exceptional phenomenon in the former case, and occurs more frequently in the latter.[1] Finally, it is extremely rare in cases of chronic pleurisy with large effusion, or in empyema, to find vesicular resonance on percussion, denoting the presence of pulmonary normal substance below the level of the liquid. In cases of mediastinal tumor, on the other hand, it will frequently, and perhaps generally, be found that the physical evidence of lung containing air in the air-cells is obtained in parts of the chest in which, if the morbid phenomena were due to liquid effusion, the gravitation of the fluid would be almost sure to abolish both the vesicular resonance and respiration.

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[1] Bulging and fluctuation are stated not to occur in dilatation from the presence of an intrathoracic tumor, but both were observed in a case of cancer in the mediastinum, already referred to, reported by Prof. Swett, in which a trifling quantity of liquid only existed within the pleural sac.

The data upon which a probable opinion that a mediastinal or other intrathoracic tumor is of a cancerous nature, are briefly the following: Hæmoptysis, and the characteristic jelly-like expectoration, or, possibly, the presence of cancerous matter, determined microscopically in the sputa, these phenomena, probably in the majority of cases, indicating a coexisting deposit of cancer within the lungs; and the existence of a cancerous affection in other parts of the body, in which the fact of its existence may be positively ascertained.

It is proper to state, that in treating of cancer of the lungs and in the mediastinum, I have relied on the observations of others, without having been able, owing to the infrequency of the disease, to verify their correctness by my own clinical studies; and I would particularly express my indebtedness to the treatise by Dr. Walshe, to which, in the course of this work, frequent reference has been already made.

CHAPTER VII.

ACUTE PLEURITIS—CHRONIC PLEURITIS—EMPYEMA—HYDROTHORAX—PNEUMOTHORAX—PNEUMO-HYDROTHORAX—PLEURALGIA—DIAPHRAGMATIC HERNIA.

THE group of diseases to which this chapter is devoted, consists of affections which are either seated in the pleura, or, as in the case of the two last named, in their situation are related more closely to this than to any other of the structures entering into the anatomical composition of the pulmonary organs. They form an interesting and important class of the diseases of the respiratory system. As regards their diagnosis, it will be found that, without the aid derived from physical exploration, they are frequently detected with great difficulty, and, indeed, in many instances cannot be distinguished from each other, or from certain of the diseases treated of in the preceding chapters. On the other hand, by means of physical signs in conjunction with symptoms, the discrimination is in general made with facility and positiveness. I shall consider these affections, respectively, in the order in which they are enumerated in the heading of this chapter.

ACUTE PLEURITIS.

In point of frequency this affection ranks third in the list of acute pulmonary diseases, bronchitis and pneumonitis taking precedence in this regard. It occurs either as an independent or a concomitant pulmonary affection. When developed as a complication of some other disease of the lungs, as in tuberculosis and pneumonitis, the inflammation is usually limited to a portion of the pleural surface: in other words, the pleuritis is circumscribed. Its occurrence in connection with the diseases just named, has been noticed in the chapters devoted to their consideration. When not thus consecutive, the inflammation is usually general, *i. e.* it extends more or less over the entire pleural membrane on one side. To this rule, however, there are exceptions. The inflammation is sometimes limited, constituting partial pleurisies, which are called, according to the portions affected, costal, pulmonary, diaphragmatic, mediastinal, and interlobar. Again, the pleuritic inflammation may be confined to one side, or affect both sides. In the former case it is *single*, and in the latter *double* pleuritis. In treating of the physical signs and diagnosis of the disease, reference will be had, in the first place, to acute general pleuritis. Partial pleurisies will be briefly noticed after treating of chronic pleuritis.

Acute general pleuritis is divided by some writers into several stages. For clinical convenience, and with especial reference to variations in physical signs, it suffices to recognize three different periods in the progress of the disease. 1st. The period from the commencement of the inflammation to the accumulation of an appreciable quantity of liquid effusion within the pleural sac. This period will comprise the dry and plastic stages of some writers. 2d. The period during which the liquid is either accumulating or remains stationary. This period may be called the stage of effusion or of liquid accumulation. 3d. The period when the liquid effusion is being removed by absorption. Perforations of the thoracic wall, and of the lung, by which the effused liquid is evacuated, in the one case directly and in the other case indirectly through the bronchial tubes, are accidental events of rare occurrence, and do not, therefore, belong to the natural history of the disease, as deduced from the phenomena occurring in the large majority of cases.

The physical conditions pertaining to the morbid anatomy, which are represented by signs in these three periods, are the following. *First.* The presence of plastic lymph, either in patches, varying in size, and more or less numerous, or sometimes diffused over the whole of the inner surface of the pleural sac. It has been hypothetically assumed that, prior to this deposit, there exists for a time an abnormal dryness of the membrane, which may give rise to acoustic phenomena. *Second.* The presence of liquid, which speedily gravitates to the bottom of the sac, compressing the lung, and displacing it in a direction upward and backward, except it have become fixed at certain points by previous morbid adhesions. The accumulation of liquid in some cases in sufficient quantity to expel by compression the air from the lung, reducing it to a small condensed mass (carnification); at length enlarging the size of the chest, depressing the diaphragm and subjacent organs, displacing the heart, and producing various alterations in the relations of the parts composing the thoracic parietes. *Third.* The diminution and ultimate disappearance of the effused liquid, accompanied by an expansion of the compressed lung, which regains, only after a time, and frequently never, its former volume. Contraction of the chest, and often persisting or permanent alterations in form, and in the relations of parts, the reverse of those which have occurred at a former stage. The pleural surfaces, in proportion as the liquid effusion diminishes, again coming into contact, roughened by a fibrinous coating more or less solidified, and in progress of organization. Finally, adhesion of the pulmonary and costal pleuræ by means of the complete organization of the intermediate plastic lymph.

The foregoing sketch of the physical conditions belonging to the different stages of the disease, will apply equally to acute and chronic pleuritis, and as regards the effects of an abundant accumulation of liquid on the walls of the chest and the intrathoracic organs, they are generally much more marked in the latter variety of the disease.

Physical Signs.—As remarked by Valleix, the phenomena belonging to the natural history of pleuritis, notwithstanding the frequency of the disease, have not been studied, by means of the analysis of clinical records, to the same extent as those of some other pulmonary affections, more especially pneumonitis and tuberculosis.[1] Nevertheless, its diagnostic traits, derived both from signs and symptoms, are well ascertained. With respect to the results of physical exploration, some interesting facts have been recently contributed.

Proceeding to present the phenomena of the different stages of this affection, as furnished by the several methods of exploration, in the order in which the latter were taken up in the first part of this work, the signs obtained by *percussion* are to be first noticed. Prior to the accumulation of liquid in sufficient quantity to gravitate to the bottom of the chest, and to occupy a certain amount of space to the exclusion of the lung, the sonorousness on percussion may not be in a marked degree altered. Moderate or slight diminution of the vesicular resonance, replaced, according to Skoda, by a tympanitic sonorousness,[2] is usually discovered, attributable to several causes, viz., lessened expansion of the lung on account of the pain attending the inspiratory act; the exudation of plastic lymph on the pleural surfaces, and, possibly, as contended by Woillez and Hirtz, the presence, during this stage, of a thin stratum of liquid uniformly diffused over the lung. The latter, which is called *laminar*, in distinction from *gravitating* effusion, is questionable; and that the lessened expansion of the lung is the chief cause of the diminished resonance, may be shown by the fact that a deep inspiration (if the patient will disregard the pain which instinctively leads him to repress the movements of the affected side), restores the normal sonorousness. Due to the causes just mentioned, individually or collectively, the diminution of resonance extends over the whole of the greater part of the affected side. During this stage especially, and frequently during the subsequent stages, percussion, unless lightly performed, is painful, owing to the soreness of the chest.

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[1] This distinguished clinical observer and author, lately deceased, at the time of his death was engaged in preparing a paper on the results of percussion in pleurisy. (*Archives Générales de Médecine.*)

[2] Although much stress is laid by Skoda on modifications of resonance which he distinguishes as *tympanitic*, yet, as remarked by M. Aran (his French translator and com-

The effusion of a sufficient quantity of liquid to gravitate, and elevate the lung to a greater or less extent, generally takes place with such rapidity, that in a large proportion of cases the opportunity of examining the chest during the first period of the disease is not offered. It very rarely happens that hospital patients come under observation before the disease has advanced to the second period. The stage of liquid accumulation may supervene even in a few hours after the date of the attack, and it is seldom delayed beyond the third or fourth day.

When the liquid accumulates at the bottom of the pleural sac, elevating the lung, the vesicular resonance is abolished from the base of the chest upward over a space corresponding to the amount of effusion. The percussion-sound is flat, except a gastric or intestinal

mentator), he nowhere gives a clear and distinct statement of the sense in which he intends to apply this term. The word tympanitic, as has been seen in Part I, is used with different latitudes of signification by different writers. From the language used by Skoda, in the chapter on pleurisy, it may be inferred that he considers a sound as tympanitic whenever it is non-vesicular, without regard to its intensity. He says, "The greater the depth of the exudation (in pleurisy), the duller the percussion-sound becomes, so that at least we are not able to recognize the tympanitic character of the dull percussion-sound." (Markham's translation, Am. Ed. p. 346.) Accepting this sense of the term tympanitic, which is precisely that adopted in this work, the doctrine of Skoda, that whenever "the lung contains less than its normal quantity of air, it yields a sound which approaches to the tympanitic, or is distinctly tympanitic," is more readily admissible, and at the same time more intelligible. Whenever the absolute quantity of air is reduced in the lung, as a rule, the relative quantity contained in the bronchial tubes exceeds that in the cells. Hence, going no farther for an explanation, while the sound becomes more dull it acquires a tympanitic quality.

tympanitic sonorousness be transmitted from below, and under these circumstances the latter rarely occurs in a marked degree. Abolition of vesicular resonance is invariable, and flatness is the rule. At the same time the elasticity of the thoracic wall is notably diminished, and the sense of resistance increased below the line indicating the upper boundary of the flatness.

If the quantity of effusion be quite small, although sufficient to elevate the lung to some extent, the evidence of its presence afforded by percussion, while the patient is in one position only, may be incomplete, owing to the normal line of flatness being variable in different persons, and on the left side in the same person at different periods. The results of percussion in different positions will often, if not generally, in such a case, establish the presence of liquid. Having ascertained and marked the point at which the vesicular resonance is lost on the posterior surface of the chest while the patient is in a sitting posture, let him then lie upon the face, waiting a moment for the liquid to gravitate to the anterior portion of the sac. Percussion may now elicit a vesicular resonance below the line indicating its lower boundary when the body was in a vertical position. But it is seldom that the quantity of liquid is so small as to leave room for doubt whether the situation of the line of flatness be abnormal. The effusion varies greatly in amount in different cases. Although usually less abundant in the acute than in the chronic variety of general pleuritis, it is usually so considerable in the former as to render it evident that the flatness found at the base of the chest is due to some morbid condition, which is in all probability intrathoracic.

Extending upward from the base over a third, a half, or two-thirds of the chest on the affected side, the line of flatness, generally defined without difficulty by percussion, marks the level of the liquid. This line may be found not to pursue a horizontal direction when the body is in a vertical position, owing to a portion of the lung being fixed below the level of the liquid by previous morbid adhesions. For example, in a case recently under observation, in which the evidence of liquid in the left pleural cavity was unequivocal, the line of flatness extended horizontally through the nipple, laterally and posteriorly, to within two or three inches of the spinal column. From this point percussion elicited a vesicular resonance for several inches below a continuation of the horizontal line, showing that at its inferior posterior extremity the lung was held down by an attachment which was sufficient to resist the upward pressure of the liquid.

Variation in the line of flatness with different positions of the patient, in a proportion of cases, larger, as I am led to suspect, than is to be inferred from the opinions expressed by most writers on this subject, is available as a test that the flatness is due to the presence of liquid, provided the chest be but partially filled with the effusion. It is not available when the pleural surfaces are adherent above the level of the fluid, nor when the lung is so much compressed that its elasticity is destroyed. In the case just referred to, in which the inferior posterior extremity of the lung was fixed at the base of the chest, the evidence of the presence of liquid was afforded by percussion over the submerged portion of the lower lobe. When the patient inclined far forward, or lay upon the face, the resonance became notably greater than when the position of the body was vertical; showing that the portion of lung was not united to the thoracic wall by a close, uniform adhesion, but by bridles or bands of false membrane.

The direction which the line of flatness is found to pursue when the patient is sitting or standing, serves to distinguish a gravitating effusion from the solidification of the lower lobe in lobar pneumonitis. In the latter case, as stated in the chapter on pneumonitis, provided the inflammatory exudation be limited to the lower lobe, and extend over the whole lobe, the situation of the interlobar fissure, crossing the chest obliquely from the fourth or fifth cartilages to the spinal extremity of the spinous ridge of the scapula, may be delineated by an abrupt change in the percussion-sound; and this line is found not to vary with the different positions of the patient. It could only be by a coincidence hardly falling within the range of probability, that a collection of liquid should happen to be confined by pleuritic adhesions within a space bounded exactly by the interlobar fissure.

The loss of elasticity and sense of resistance on percussion are greater in proportion as the effusion is abundant, being strongly marked when the quantity is sufficient to produce considerable enlargement of the chest.

The abolition of sonorousness is usually more complete below the level of a considerable quantity of liquid, than over lung solidified by inflammatory or other exudation. The sound in the former instance is flat; in the latter, more or less dull, the presence of air within the bronchial tubes and some of the cells preventing total extinction of resonance, which, under these circumstances, is not vesicular, but tympanitic in quality. Perfect flatness, therefore, although not conclusive evidence of the presence of liquid, for it may be caused by an intrathoracic tumor, and occasionally even by consolidation of lung, warrants a strong presumption that effusion exists. And this presumption is rendered still stronger by the flatness being found to extend from the base of the chest upward, the line indicating its upper limits being well defined, and pursuing a direction, if the body be in a vertical position, extending horizontally, or nearly so, around the affected side.[1]

In cases in which the quantity of liquid is large, distending the chest, and compressing the lung into a solid mass, either flatness exists universally over the affected side, or, at all events, there is complete abolition of vesicular resonance, and the flatness may not be confined to the affected side. The accumulation of liquid, when large, produces a lateral displacement of the mediastinum, and the distended pleural sac may even encroach on the opposite side, giving rise to dulness on percussion, sometimes extending from half an inch to an inch beyond the sternum. But when the effusion is less abundant, the fluid rising to within a third, a half, or two-thirds of the distance from the base to the top of the chest, percussion over the compressed lung, above the level of the liquid, furnishes interesting results. The sonorousness is frequently increased, being greater than in a corresponding situation on the opposite side, and it becomes more or less tympanitic in quality. This fact had attracted, in occasional instances, the attention of several observers, but the frequency of its occurrence has only of late been ascertained. The existence of a tympanitic resonance above the level of the liquid, in cases of pleuritis, is probably the rule, and an exaggerated sonorousness in the same situation, according to the observations of Dr. Roger of Paris, provided the quantity of liquid be neither very large nor quite small, exists for a greater or less period during the progress of the disease, in a large proportion of cases. The tympanitic resonance over the lung above the liquid may have a metallic character, resembling the high-pitched, peculiar sound, obtained frequently by percussing over the stomach. A French observer, M. Notta, has recently reported two cases in which this character of sonorousness was strongly marked. On the left side, it might be suspected that the sound was actually transmitted from the stomach; but in the cases reported by M. Notta, the effusion was on the right side.[1]

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[1] It is stated (Traité de Diagnostic, etc., par le Docteur V. A. Racle), that when a certain quantity of liquid is contained within the pleural sac, and the pleural surfaces are free from adhesions, the body being in a vertical position, the level is not exactly horizontal, the fluid rising somewhat higher behind than in front.

Even the cracked-metal modification of tympanitic sonorousness has been observed by Stokes, Walshe, Roger, and Bouillaud, at the summit of the chest in cases of large effusion within the pleural sac.

During the progress of the removal of the liquid by absorption, the vesicular resonance gradually returns, extending from above downward in proportion as the level of the fluid is lowered. Diminution of vesicular resonance, however, as compared with the healthy side, with or without the substitution of a tympanitic sonorousness, persists for an indefinite period; and, owing to the slowness with which absorption usually goes on after the quantity of liquid has been considerably reduced, flatness continues for a long time at the base of the chest.

The displacement of intra-thoracic parts arising, on the one hand, from the pressure of a large quantity of effusion, and, on the other hand, from the suction-force developed by the absorption of the liquid, will be mentioned presently, in connection with palpation. As I have referred, however, already to the lateral displacement of the mediastinum, it may be added that, after absorption, a reverse displacement is liable to take place, and the sonorousness due to the encroachment of the lung of the healthy side may be apparent even beyond the sternum on the side in which the effusion has existed.

Auscultation furnishes results which, in a positive and negative point of view, are of great importance in the diagnosis of pleuritis. Feebleness of respiration on the affected side belongs to the period anterior to the stage of liquid accumulation. In quality and pitch, the respiratory sound is not materially changed. The intensity is alone altered—a result chiefly of the restrained expansion of the side affected. The murmur is frequently interrupted or jerking, owing to a want of continuity in the respiratory movements, an effect of the acute pains incident to this stage.

During the period of effusion, the effects of the accumulation of liquid, as regards the respiratory sound, are always marked, but varying in different parts of the affected side; and the phenomena are by no means uniform in all cases. With a very small amount of fluid gravitating to the bottom of the chest, producing a slight degree of compression of the lung, the respiration will be likely to continue feeble, with some of the characters of the broncho-vesicular modification—the inspiratory sound less vesicular than on the opposite side, and higher in pitch, and perhaps a prolonged expiration. If, however, the quantity of liquid be considerable or large, filling at least one-half or two-thirds of the chest, the results of auscultation practised above and below the level of the fluid, are usually in striking contrast with each other. Over the condensed lung, the abnormal characters are of the broncho-vesicular or the bronchial variety, according to the degree of condensation of the pulmonary structure. One or the other is generally more or less strongly marked. The intensity is variable in different cases. In some instances it is loud, in other instances feeble. It is oftener feeble, but as exceptions to the general rule, I have observed a pretty strongly marked exaggerated vesicular murmur, emanating from the lung above a moderate effusion. Below the line of flatness on percussion, indicating the level of the liquid, the respiratory sound is frequently suppressed.[1] The loss of sound, if the stethoscope be employed, is often abrupt, denoting, like the sudden loss of sonorousness on percussion, the height to which the liquid ascends in the chest. This account probably expresses the rule, as respects the respiratory phenomena, above and below the liquid effusion, in cases in which the latter is more or less abundant. But there are important exceptions to this rule. In some instances in which a loud bronchial respiration is heard over the condensed lung, it is propagated below the level of the liquid, and may extend over the entire side. This fact has been repeatedly noted by numerous observers, even in cases in which a very large amount of effusion existed, producing considerable enlargement of the affected side. A well-marked bronchial respiration, diffused over the entire side, characterizes a certain proportion of the cases of pleuritis with large effusion. The ratio of instances in which this occurs is yet to be settled by numerical analysis. The number of instances in the adult is not sufficient to render them other than exceptions to a general rule. In early life, the ratio is larger. Indeed, according to Swett, a bronchial respiration more or less extensive is the rule, not the exception, in pleuritis affecting young children.

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[1] Archives Générales de Médecine, 4 série, t. xxii, Avril, 1850.

In general, when a bronchial respiration is diffused over the side, in cases of abundant or large effusion, certain points of difference pertain to the sign, as heard above and below the level of the liquid. Over the condensed lung, it is more intense, and conveys the idea of proximity to the ear. Over the liquid, it is more feeble, and seems to be transmitted from a distance.

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[1] The sounds of the heart are transmitted with an abnormal intensity through the mass of liquid. In cases in which the right side is filled with fluid, the heart-sounds are heard with great distinctness. Auscultation of the heart is one of the means of ascertaining the displacements of this organ which are noticed presently, in connection with palpation.

When the effusion is very copious, filling and dilating the affected side, and compressing the lung into a small, solid mass, the respiratory sound, in the adult, at least, is usually suppressed over the greater portion of the chest. A bronchial respiration, either feeble or more or less developed, under these circumstances may frequently be detected at the summit of the chest, sometimes below the clavicles, but more frequently behind, above the spinous ridge of the scapula, and more especially in the upper portion of the interscapular region. It is rarely altogether wanting in one or more of these situations.[1] From the summit it may extend, with diminished intensity, conveying the sense of distance, over a variable area. The bronchial respiration will be more intense and more diffused if, in addition to the condensation from compression, the lung is solidified, either by inflammatory exudation or a tuberculous deposit. A loud and persisting bronchial respiration warrants a suspicion of pulmonary consolidation.

In a recent publication by MM. Monneret and Barthez, of Paris,[1] it is stated that the respiration over the condensed lung in pleuritis may assume the characters of the cavernous and even the amphoric modifications. As described by these writers in the cases reported by them, I am unable to perceive any evidence of other than intense bronchial respiration. The intensity, in fact, appears to have been considered by them as the proof of its cavernous character. But a cavernous respiration is by no means always as intense as a loud bronchial respiration. The intensity is but an incidental element of both. That the two are not infrequently confounded even by experienced auscultators, I am fully persuaded. If the distinctive characters of each (having reference especially to the relation of the pitch of the inspiratory and expiratory sound) are correct, as they have been pointed out in Part. I, and also in the chapter on Pulmonary Tuberculosis, it is impossible for a true cavernous respiratory sound to be developed in connection with solidification of lung. It is proper, however, to add, that the occurrence of cavernous respiration in some cases of pleuritis, without excavations, is admitted by Barth and Valleix.

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[1] MM. Barth and Roger found the bronchial respiration absent in 17 of 26 cases of pleuritis, selected indiscriminately, as quoted in Part I of this work. The experience of others goes to show that it is discoverable at the summit of the chest in a larger proportion of cases than this; and the latter accords with my own impressions. Further numerical results with respect to this point are to be desired. Valleix suggests that the disparity between the results obtained by Barth and Roger, and other observers, may be explained by the former studying the effect of natural or tranquil respiration, and the latter causing the patients examined to breathe with quickness and force. The influence of forced breathing in developing and increasing the intensity of the bronchial as of the normal respiratory sound, is well known to practical auscultators.

[2] Archives Générales de Médecine, Mars, 1853. Vide, also, Valleix, op. cit. vol. i, p. 570.

In the instances referred to in the preceding remarks, I am led to suppose that the bronchial respiration may have been mistaken for the cavernous. But a mistake may arise, if, in connection with a certain amount of liquid effusion, the respiration (as may occur) is neither bronchial nor broncho-vesicular, but intensely vesicular, or in other words, highly exaggerated. The latter effect on the side affected in single pleuritis, I suppose to be very rarely produced, but I have already referred to it as a possible occurrence. I have observed this effect to be marked in a case of double pleuritis, to which allusion has been already made in treating of cavernous respiration in Part I.

A patient was admitted into hospital apparently in the last stage of pulmonary tuberculosis, and died a few days after his admission. A single exploration of the chest only was made, which, on the presumption of the case being one of advanced tuberculosis, was limited to the summit of the chest; and from the great weakness of the patient was confined to the anterior surface. The superior costal type of breathing was observed to be remarkably predominant, the patient being of the male sex. A clear resonance on percussion with tympanitic quality existed at the summit. The respiratory sound was loudly developed, the inspiration low in pitch, and followed by an expiration shorter, less intense, and lower than the sound of inspiration. Moreover, at the commencement of the inspiratory act, the sound appeared to present a slight amphoric intonation. These were the characters on both sides, and upon them, without an elaborate examination, as already stated, was predicated the opinion that the respiration was cavernous. At the autopsy I expected to find large excavations at the apex of both lungs; but instead of this, there was double pleuritis. The chest on both sides was about two-thirds filled with liquid, the pleural surfaces being firmly adherent above the level of the fluid. A vesicular murmur, thus, highly exaggerated from the fact that the upper portion of the lung on each side was alone available for respiration, and from the great development of the superior costal type of breathing, presenting certain of the characters of the cavernous respiration, was mistaken for the latter in a case in which the general aspect suggested only the idea of advanced tuberculosis. The error of observation was of course due to carelessness in physical exploration, and the lesson to be enforced by it is too obvious to require comment. The case illustrated the law laid down by Louis, that double pleuritis generally involves the existence of tuberculosis; for although excavations were wanting, small tuberculous deposits, not exceeding the size of a small pea, which had not advanced to softening, were found in both lungs.

So far as the amphoric modification is concerned, according to the authors above named (Barth and Valleix), the sound in the so-called cavernous respiration incident to pleuritis, does not become distinctly amphoric, but only approaches that character. A bronchial respiration with a metallic intonation is an approximation to the amphoric respiration.

During the period of absorption, the expansion of the lung taking place in proportion, as the compressing agent is removed, the bronchial respiration, if it have existed, disappears, giving place to the broncho-vesicular, which gradually assumes more and more of the vesicular quality. The respiration, as absorption goes on, becomes audible, or resumes its normal characters, progressively from the summit downward. Absorption, when the liquid is reduced to a small quantity, taking place frequently very slowly, absence of respiration with dulness or flatness on percussion, often continues for a long time at the base of the chest. Feebleness of the respiratory murmur over the whole side, characterizes the renewal of the function of the compressed lung. This continues for weeks or even months. The permanent effects following recovery from pleuritis with large effusion, will be noticed under a distinct head in connection with the chronic variety of the disease.

Finally, on the unaffected side during the three periods of the disease, but especially during the stage of liquid accumulation, the intensity of the respiratory murmur is abnormally increased, constituting exaggerated or supplementary respiration.

Of adventitious auscultatory sounds, the bronchial rales are occasionally heard in cases of pleuritis. Their occurrence is purely accidental. Bronchitis and pulmonary catarrh coexist with pleuritic inflammation only as coincidences. The inflammation does not extend to the parenchyma of the lungs, and, consequently, the crepitant rale does not belong to the clinical history of the disease. Adventitious sounds, however, may be developed within the pleural sac, which are highly significant. I refer to attrition or friction sounds. If patients come under observation in the first period, or before much liquid accumulation has taken place, a grazing or rubbing sound may sometimes be detected over the lower part of the anterior or lateral surface, and in rare instances, during this period, it is audible over the greater part of the affected side. The production of the sound at this stage must be due, in most cases, to the deposit of fibrin on the pleural surfaces. It is possible that the increased vascularity of the superficies of the lung, together with the absence of the usual exhalation lubricating the pleura, may be adequate to produce it. Walshe gives an instance in which a loud rubbing sound was heard over the whole side, and after death, which occurred sixteen days from the time when this sign was noted, the pleural surface was found to be entirely free from lymph, except over a spot of the size of half a crown. The sound is heard in a certain proportion only of the cases which are examined anterior to the stage of effusion. The restrained movements of the affected side from pain are sometimes insufficient for its production, and then it may be developed by inducing the patient to disregard the pain and expand the side more fully. It would perhaps be detected at this period oftener than it is, were the side to be more frequently examined than is usual, and the explorations made with care over every point; for the sign is frequently intermittent, and may be confined to a small space.

After the accumulation of liquid, and during the stage of effusion, a friction-sound is rarely discovered. In exceptional instances it is observed, in this period, over the compressed lung. According to Walshe, it may occasionally be developed on the back by making the patient lie on the face for a little while. It has been observed, also, over a considerable area, even when the quantity of liquid is quite large. In the latter case it is attributable to the lung having become attached, by means of bands or bridles of false membrane, to the thoracic wall, which resist the pressure of the fluid, and permit the pleural surface to come into contact over a certain space, notwithstanding the amount of effusion.

It is during the third period, or the stage of absorption, that friction-sounds are most apt to occur in pleuritis. The pleural surfaces, after having been separated by the presence of liquid, are again brought into contact, more or less coated with semi-organized lymph. It is only during this stage that the rougher sounds, called *rasping* or *grating*, are produced. They may have this character, or in the third stage, as in the first, only the *rubbing* and *grazing* varieties may be developed. They are sometimes loud and strong, occasionally heard at a distance, attracting the patient's notice, and accompanied by a vibratory motion of the parietes perceptible to the touch. Their duration is variable. They may last for a very brief period, and, on the other hand, they have been known to continue for months.

Friction-sounds by no means constantly attend the stage of absorption. The adhesion of the pleural surfaces, which quickly ensues, prevent their development. They would probably be more frequently discovered than they are, if repeated examinations were made for that object; but at this period of the disease they are generally unimportant as regards the diagnosis, which has been already made, and they are generally sought for merely as a matter of curiosity.[1] As evidence, however, that the pleural surfaces are again in contact, the sign is not altogether unimportant at this stage of the disease. Its occurrence subsequent to liquid accumulation is, of course, a proof of progress having been made in absorption; but this point is generally easily settled by other signs which are more uniformly available.

In conclusion, friction-sounds are chiefly important, in a diagnostic point of view, when they are discovered early in pleuritis, because it is only at this period that the discrimination of the disease, as a general remark, is attended with any difficulty. When they are heard at the middle or inferior portion of the chest, or are found to extend over the whole side, they are almost pathognomonic. Taken in connection with symptoms characteristic of pleuritic inflammation, their presence establishes the diagnosis. In a negative point of view, however, they are of not much importance: that is, their absence is not evidence that pleuritis does not exist, owing to the want of constancy in their association with the disease.

For the characters which distinguish friction-sounds, and by which they are to be recognized clinically, as well as for other practical considerations connected with their production, the reader is referred to the portion of the chapter, in Part I, on Auscultation in Disease, which is devoted to this subject.[1] The liability of mistaking a friction-sound for a crepitant rale is to be borne in mind, since, practically, it might lead to the error of confounding pleuritis with pneumonitis. The occasional occurrence of a pleural friction-sound produced by the heart, exclusive of any disease of the latter organ, is an item among the curiosities of clinical experience, which is to be recollected. The movements of the heart sometimes cause a rubbing of the adjacent pleural surfaces sufficient to give rise to a sound. Its disconnection from other evidences of pericarditis, and association with the other evidences of pleuritis, will prevent mistakes.

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[1] Bouillaud professes to discover friction-sounds, almost invariably after absorption, in cases of pleuritis (Valleix, op. cit.). This may be explained on the supposition that he is accustomed to take greater pains than others in seeking for them.

The results of auscultation of the voice are to be taken into account in the diagnosis of pleuritis. The results before the stage of effusion, if not altogether negative, are not sufficiently marked to possess diagnostic importance. They are variable after accumulation of liquid has taken place, but are frequently useful in confirming the evidence derived from other signs. Over the compressed lung the vocal resonance may be abnormally exaggerated; well-marked bronchophony is sometimes observed, and the occasional occurrence of pectoriloquy, under these circumstances, is sufficiently established. These vocal phenomena may all be absent, and are present in different cases with greater or less intensity or prominence. They are more marked if, in connection with pleuritic effusion, the lung be solidified, not by compression only, but by inflammatory consolidation or a tuberculous deposit. When strongly marked they afford presumptive but not positive evidence of solidification, in addition to the condensation due to the pressure of liquid effusion. If not strongly marked, they are significant of condensation, or some abnormal condition, on the left more than on the right side, owing to the normally greater vocal resonance on the right side. This remark is applicable to exaggerated vocal resonance only, not to bronchophony and pectoriloquy.

These vocal signs are generally limited to the summit of the chest, and confined to an area circumscribed in proportion to the space occupied by the compressed lung. They are oftener discovered over the scapula and in the interscapular region behind, owing to the usual situation of the compressed lung in cases of large effusion.

Over the space occupied by liquid, the vocal signs which have been named are usually wanting. A contrast as regards vocal resonance between the upper and lower portion of the affected side, when the percussion-sound is at the same time observed to be flat below, and more or less sonorous above, is pretty conclusive evidence of the presence of liquid; for if the relative flatness at the inferior portion of the chest proceeded from greater solidification of lung, the vocal resonance would be expected to be more marked than at the superior portion of the chest, where a certain amount of resonance is elicited by percussion.

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[1] Vide, page 242.

In like manner, a contrast between the two sides inferiorly, consisting in the presence of vocal resonance on the healthy side, and its absence on the affected side, affords strong proof of effusion. Here the allowance for a normal disparity between the two sides, is the reverse of that to be made when it is a matter of question as to solidification of lung at the summit. If the flatness on percussion be on the right side, and the greater vocal resonance on the left side, the proof of effusion in the right pleura is stronger than it would be were the left side the one affected.

But auscultation furnishes a vocal sign deemed by Laennec pathognomonic of pleuritic effusion, and still considered by many as highly significant. I refer to the sign called *Ægophony*. A singular discrepancy of opinion exists among different observers as regards the frequency with which this sign is discoverable in pleuritis, the extent of its diffusion, and its diagnostic importance. This discrepancy may perhaps in part be accounted for on the supposition that the term ægophony is used by some in a more comprehensive sense than by others. It may be applied to slight modifications of the transmitted voice, or it may be restricted to instances in which the tremulousness and acuteness are sufficiently distinct to constitute at least some approach to the bleating cry of the goat, or the other sounds to which it has been compared.[1] Without dwelling on the subject here, I shall refer the reader to the remarks under this head contained in the chapter on Auscultation in Disease, in Part I.[2] That ægophony is properly regarded as a physical sign distinct from bronchophony and pectoriloquy, is unquestionable. That it is highly significant of pleuritic effusion, when well marked, appears to be sufficiently established. I am free to confess, however, my inability to speak of its value from much practical acquaintance with it; but this is perhaps owing to the fact that I have not made it the subject of much clinical study, repeated disappointments in seeking for it having led me to distrust its availability. The reader will, of course, attach due weight to this confession in connection with the remarks in Part I, to which he is referred.

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[1] The distinction between transmitted voice and transmitted speech is to be kept in mind. The former is bronchophony; the latter pectoriloquy.

[2] Vide page 267.

Inspection and mensuration furnish striking and valuable signs in pleuritis. Under the influence of pain the movements of the affected side are so far restrained by the will, as to give rise to a perceptible diminution in expansion by the inspiratory act, and on measurement, the size, as also the range of motion, may be found slightly reduced during the first period. The voluntary restraint of motion is especially apparent in the act of coughing. These results give place to others more marked and distinctive in the second stage. The lower part of the affected side, in proportion to the amount of liquid accumulation, becomes dilated, and the inferior costal movements, with respiration, are lessened or arrested. The intercostal spaces exhibit less depression, and are generally not so deeply indented in the inspiratory act, as on the opposite side.

Accumulating in still larger quantity, the liquid meets with more resistance from the condensed lung than from the thoracic parietes, and the latter accordingly yield to the dilating force. The affected side becomes conspicuously enlarged, and its range of motion in respiration proportionally limited. It is dilated frequently to the fullest extent of voluntary expansion, or even beyond this limit, and hence remains motionless, while the movements of the opposite side are supplementarily increased. The intercostal depressions are now abolished, and a slight convexity between the ribs may in some instances be apparent. Over the lower and middle portions of the side the ribs are abnormally separated, while at the summit they converge more than is natural. The obliquity in the direction of the ribs is diminished. Approaching to a horizontal line, their angular union with the costal cartilages is no longer obvious. Measurement of the semicircular circumference, of the vertical distance from the base to the summit, and, by means of callipers, of the antero-posterior diameters, shows an increase of size in all directions. The nipple is somewhat elevated, and is removed at a greater distance than on the opposite side from the median line. On a posterior view a marked contrast is observed between the two sides in the elevation of the scapula with the act of inspiration.

These are the phenomena, determined by inspection and mensuration, which denote a very large accumulation of liquid within the pleural cavity. Occasionally presented in acute pleuritis, they are much oftener observed in the chronic form of the disease.

In the progress of absorption of the effused fluid, a series of changes take place, the reverse of those which characterize progressive accumulation of fluid. The enlargement decreases; the bulging intercostal spaces become flattened; the divergence of the lower ribs diminishes, and they assume a more oblique direction; the nipple falls, and its distance from the median line is lessened; some degree of expansive movement is perceptible, taking place more slowly than on the opposite side, and depression of the side at the summit is apparent. With these changes the affected side may be still nearly filled with liquid. Finally, when absorption of the whole or a greater part of the liquid is effected, the alterations in size, motions, and relations of the different parts are frequently still more marked. The side becomes contracted in every direction. It is obvious to the eye at the lower, as well as at the upper part, when the chest is examined either behind or in front. Mensuration with the inelastic tape, or with callipers, shows this to be the case. Lateral curvature of the spine is apt to occur, the concavity looking toward the affected side. The shoulder (with occasional exceptions) is depressed; the interscapular space is narrowed; the lower angle of the scapula projects from the thoracic wall; the lower ribs approximate more than on the opposite side; the nipple falls below the level of its fellow, and is nearer the median line; the range of motion in the acts of respiration is greater than before, but still limited on comparison with the healthy side. These changes always succeeding chronic pleuritis with large effusion, but not so constant after the acute variety, in amount bear a certain proportion to the extent to which the side has been previously expanded; in other words, to the quantity of liquid effusion which has existed. They are, however, also dependent on the condition of the compressed lung as regards its ability to become expanded as the pressure is removed; and since this condition is affected by other circumstances than simple condensation, viz., by the adhesion of the pleural surfaces, and the organization of lymph deposited upon it, the contraction of the side resulting from pleuritis will differ in different cases in which the quantity of effused liquid was about the same.

Contraction of the affected side after pleurisy will be likely either to be wanting entirely, or to be less marked and less persisting in proportion as the effusion and its removal by absorption have been rapid. For this reason, assuming an equal amount of accumulation, the changes first mentioned characterize chronic rather than acute pleuritis. But they are more apt to follow chronic pleuritis for another reason, viz., the quantity of liquid effused is usually much greater in this variety of the disease. The rapidity with which absorption goes on in acute, as well as in chronic pleuritis, varies much in different cases. It is not uncommon to observe a very great reduction within a few days or even hours; but after the quantity is reduced to a certain point, the removal is always effected more slowly. The side may be obviously depressed at the summit or middle third, when it is still enlarged at the lower part, as shown by mensuration. As regards permanent effects on the chest, there may not be any obvious disparity after the lapse of weeks or months succeeding an attack of the acute form, even when the quantity of liquid effusion was considerable, and a certain amount of contraction was evident immediately after recovery. It is otherwise, however, with cases of chronic pleuritis; and I shall refer to this point under the head of the latter.

Examinations of the chest by inspection and mensuration in cases of pleuritis, are not only useful in order to ascertain the existence or non-existence of either dilatation or contraction, but that the progress of the disease may be watched from day to day, as regards, in the first place, the increase in the accumulation of liquid, and in the second place, its decrease by absorption. In cases in which the affected side is filled with fluid and the thoracic wall expanded, percussion and auscultation do not afford the means of determining from day to day variations in the quantity of effusion. Inspection and mensuration are available for this object, and the results may be important in determining the practitioner either to continue or to change his therapeutical measures.

Much interesting and important information is frequently derived from the employment of palpation in cases of pleurisy. In the first period it furnishes evidence of tenderness to the touch, and also that the soreness is not in the integument but in the intra-thoracic structures. The pain produced by manual examination of the affected side is not superficial and occasioned by mere contact of the hand, as in some instances of hyperæsthesia of the surface, but is more deeply seated and proportionate to the degree of pressure made.

But it is more especially during the second and third periods that this method of exploration furnishes useful facts. The effect of an accumulation of a considerable quantity of liquid is usually to abolish the normal vocal fremitus on the affected side over a space corresponding to that occupied by the effusion. And at the same time, in some instances, the fremitus is increased over the condensed lung above the level of the liquid. Marked diminution or suppression of the normal vocal fremitus may thus constitute a physical sign of liquid effusion, the more significant, because over consolidated lung the fremitus is frequently exaggerated. It is obvious that to become a sign of effusion, absence of fremitus must be associated with other signs; and it is to be borne in mind that in many persons the normal fremitus is greater on the right than on the left side. If flatness on percussion at the lower part of the chest coexists with absence of fremitus, while on the opposite side there exists vesicular sonorousness with a fremitus more or less marked, the evidence is strong that the flatness is due to effused fluid rather than solidified lung. And inasmuch as in some persons a fremitus exists naturally on the right side and not on the left, the evidence is stronger when the effusion is into the right pleural sac; in other words, flatness on percussion with absence of fremitus, indicates effusion more positively on the right than on the left side, making due allowance for the fact that this combination of signs may be produced by the encroachment of an enlarged liver on the thoracic space.

Palpation furnishes still other facts. By this method better than by inspection are ascertained the most important of the displacements of intra-thoracic parts which take place in the second and third periods of pleuritis with large effusion. An accumulation of liquid in the left pleural sac removes the heart from its normal situation. This may occur, and to a great extent before the thoracic parietes become dilated. Occasionally the heart is pushed downward in a direction toward the epigastrium, but in the great majority of instances it is carried upward and outward in a diagonal line extending from the præcordia to the right shoulder. It is found, as the fluid accumulates, to be situated beneath the sternum, and at length its pulsations may be felt and frequently seen on the right side, and sometimes beyond the nipple.[1] If, on the other hand, the effusion be within the right pleural sac, and the accumulation be large, the heart is displaced in a direction upward and outward toward the left axilla. If the impulse of the dislocated heart can neither be seen nor felt, which must be rarely the case except when it is beneath the sternum, the sounds of the organ, as determined by auscultation, must be the guide to its abnormal situation. Its return to the præcordia is evidence of the progress made in the absorption of the effused fluid. In some instances it has been observed to regain its normal situation in the course of a few days and even hours, showing very rapid diminution in the quantity of effusion. It does not, however, always return to its normal situation when the force which in the first instance pushed it out of place is no longer operative. It may be detained in its abnormal position by morbid attachments. And it is a curious fact that the suction-force developed by the absorption of the effused liquid may not only prevent the organ when displaced, from again resuming its position in the præcordia, but it may prove an active cause of displacement. In cases of copious effusion within the right pleura, after absorption, the heart has been found to be drawn into the right side; and subsequent to the removal of an effusion in the left pleura sufficient to displace the heart to the right, it may at length occupy a position to the left of the præcordia.

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[1] Alteration of the heart-sounds, even with the greatest amount of displacement, is very rarely observed. A bellows' sound is occasionally developed, which disappears when the heart resumes its normal situation. The existence of a murmur, under these circumstances, therefore, is not proof of cardiac disease, even excluding anæmia.

Displacement of the diaphragm is another of the mechanical effects of a large effusion. This, according to the observations of Stokes, may take place suddenly, so that the fluid finding additional space in this direction, the semicircular circumference of the affected side may possibly be diminished, and the line of percussion-flatness on the chest lowered, although the quantity of liquid is increasing. The depression of the diaphragm of course carries downward the subjacent organs. On the right side this is evidenced by the lower situation of the liver. Under these circumstances, owing to the convexity of its upper surface and the convexity of the depressed diaphragm, a sulcus or furrow is sometimes apparent between the lower margin of the chest and the point at which the anterior surface of the liver projects against the abdominal wall. Again, after absorption, the diaphragm is drawn upward with the subjacent organs above the point at which it rises normally within the chest; and the liver on the right side, or the stomach and spleen on the left side, are found to ascend higher than in health. The latter changes, however, are ascertained by percussion rather than by palpation, and the same remark is applicable to lateral displacement of the mediastinum, to which reference has been already made under the head of Percussion.

Owing to the abolition of the intercostal depressions during the stage of effusion, the affected side offers to the touch, as well as to the eye, an unnaturally regular and smooth surface, which is afterward lost when contraction of the chest takes place, and finally, in some instances, the presence of liquid in the pleural sac may be made to give rise to a sense of fluctuation appreciable by palpation. This may be discovered occasionally, by applying the left hand over the affected side at the base, and percussing the ribs with the pulpy portion of the fingers of the right hand. In thin persons, peripheric fluctuation, as it is called, is oftener available. If a finger be applied over an intercostal space, and a light, quick percussion-stroke be made at a short distance in the same space, the peculiar shock significant of the presence of fluid may be appreciable.

Diagnosis.—Certain of the symptoms of acute pleuritis are somewhat distinctive. Pain is usually a prominent symptom during the first period. It is sharp, lancinating in character, felt generally with the act of inspiration, and its severity increasing with the progress of the act, renders the latter interrupted, and shortens its duration. In these respects, however, it does not differ from the pain in pleuralgia. It is referred oftenest to the lower part of the affected side laterally, and in front; sometimes extending to the back or over the whole side, and occasionally felt exclusively on the opposite side or in the abdomen. It diminishes as effusion takes place, and at length ceases to be prominent or disappears. The respirations are multiplied at first, by way of compensation for their incompleteness in consequence of pain, and afterward from the interruption of the function of the lung on the affected side due to its compression. Dyspnœa occurs in only a small proportion of cases, which are characterized by rapid and copious effusion. Cough is sometimes, but rarely, absent. It is usually dry, excited spasmodically, and partially suppressed to avoid the pain which it occasions. The significance formerly attached to position or *decubitus*, at different stages of the disease, appears to be in a great measure disproved.

With an adequate knowledge of the physical signs which belong to acute pleuritis, the diagnosis, certainly in the great majority of cases, is sufficiently easy. It presents difficulties only to those who do not qualify themselves to employ physical exploration. By those who rely exclusively on the diagnostic symptoms, it is not infrequently confounded with pleurodynia, intercostal neuralgia, and pneumonitis. Instances illustrating these errors of diagnosis have repeatedly fallen under my observation. It will suffice to point out the more important of the circumstances involved in the differential diagnosis from the affections just named, commending to the student the study of the physical signs of the disease until they become perfectly familiar.

In pleurodynia and intercostal neuralgia, the physical phenomena which attend the march of acute pleuritis are wanting. The absence of these phenomena enables us either to exclude pleuritic inflammation, or to establish its existence. In a purely neuralgic or rheumatic affection, however, diminished expansion of the affected side, with slight reduction in size, feebleness of the respiratory murmur and perhaps relative dulness may be present, these results being due exclusively to the restrained movements from pain. The affected side may also be more exquisitely tender on pressure than when pleuritic inflammation exists. Guided alone by the results of exploration, for a brief period after the attack, the discrimination might involve doubt. The existence of marked febrile movement is an important point at this period. Symptomatic fever constantly accompanies acute inflammation of the pleura, while it attends pleurodynia and intercostal neuralgia only as a coincidence. If a friction-sound be discovered which we are satisfied is pleural in its origin, it renders the diagnosis quite positive. But the constancy of this sign cannot be relied upon, and, indeed, it is rarely discovered in the early stage of pleuritis. Its absence, therefore, is not proof that a doubtful affection is either neuralgic or rheumatic.

But the occasion for hesitancy usually exists for a brief period only. The occurrence of serous effusion, if the disease be acute pleuritis, gives rise to positive signs, which render certain the presence of something more than a neuralgic affection or an attack of rheumatism seated in the thoracic walls. And, on the other hand, the absence of the physical evidence of effusion authorizes an exclusion of acute pleuritis. A fact, however, observed by Louis and others, is important to be borne in mind, viz., an attack of acute pleuritis is occasionally preceded by a neuralgic affection of the side in which the inflammation becomes afterwards developed. Two instances illustrating this fact have come under my observation, in which the patients experienced acute pains in the side, without febrile movement, or any of the physical signs of pleuritic inflammation, for several days before an attack of the latter which was signalized by a chill, increased pain, and febrile movement.

In the differential diagnosis from acute pneumonitis, we have to distinguish between the physical signs belonging respectively to this affection and acute pleuritis. In pneumonitis there occurs, often within a short space of time, marked dulness on percussion over a certain portion of the affected side. If the upper lobe be first inflamed, the dulness will be found at the summit and on the anterior surface, while the posterior surface below the scapula is resonant on percussion. The reverse obtains in acute pleuritis after effusion has taken place. But in the majority of instances, pneumonic inflammation attacks the lower lobe, and in the lobar form invades speedily the entire lobe. The dulness will then be found to be bounded on the chest by a line pursuing the direction of the interlobar fissure, and not to vary with the change of position of the patient, the latter being observable in a certain proportion of the cases of pleuritis with effusion. The liquid in pleuritis generally accumulates rapidly, and the flatness on percussion is found to extend over a larger portion of the affected side than in cases of pneumonitis. In certain cases of pneumonitis, it is true, the entire lung may become solidified; but in these cases a single lobe is first attacked, and at a subsequent period the inflammation crosses the interlobar fissure, and invades the other lobe. If such cases are under observation from the beginning, the length of time occupied by the extension of dulness over the chest distinguishes the disease from acute pleurisy.

Other differential points are not less distinctive. The presence of a considerable quantity of liquid in the pleural cavity gives rise to flatness on percussion. Solidification of lung produces only dulness, and, in a certain proportion of instances, the vesicular is replaced by tympanitic sonorousness, more or less marked. The dulness from solidified lung is accompanied, generally, by a well-marked bronchial respiration, frequently intense, metallic, and appearing to be developed near the ear. The flatness from the accumulation of liquid is usually associated with suppression of respiratory sound; or, if a bronchial respiration be discovered, it is comparatively feeble and distant in the great majority of instances. Increased vocal resonance, bronchophony, and occasionally pectoriloquy, are signs belonging to solidification; their absence is the rule over liquid effusion. Ægophony is occasionally heard over the latter, and rarely over the former.

Vocal fremitus is often exaggerated by solidification, and it is abolished by the presence of liquid.

An accumulation of a large quantity of liquid in the pleural cavity produces considerable or great enlargement of the affected side, and effaces the intercostal depressions. In pneumonitis, the enlargement is slight, and the intercostal depressions remain. Displacements of the heart, diaphragm, and mediastinum, are marked effects of copious liquid effusion, and they occur but to a slight extent as results of solidification.

Moreover, a symptom and a sign almost pathognomonic of acute pneumonitis are wanting in acute pleuritis, viz., the rusty expectoration and the crepitant rale.

Exceptional variations from general rules as regards the physical signs belonging to the two diseases just contrasted, can alone constitute sufficient ground for hesitation in making the differential diagnosis. For example, in some cases of pleuritis with large effusion, a bronchial respiration is found to pervade the whole of the affected side; and, on the other hand, in some cases of solidification from pneumonitis, absence of respiratory sound is equally extensive. Attention, however, to other points of contrast, in all such instances, will develope ample data for the discrimination.

SUMMARY OF PHYSICAL SIGNS BELONGING TO ACUTE PLEURITIS.

First Period, viz., prior to Accumulation of Liquid.—Moderate or slight diminution of vesicular resonance, or dulness on percussion. Feeble and interrupted respiratory murmur. No alteration in vocal resonance or fremitus. Diminished expansibility of the affected side. Tenderness on pressure. Occasionally a grazing or rubbing friction-sound.

Second Period, or Stage of Accumulation of Liquid.—Flatness on percussion from the base of the chest, extending upward, more or less, over the affected side; diminished elasticity of thoracic parietes, and sense of resistance notably increased. Tympanitic sonorousness varying in degree above the level of the liquid, frequently exceeding in intensity the sound on the opposite side. Amphoric or metallic modification of resonance at the summit, sometimes strongly marked, and occasionally the cracked-metal variety of sound discovered. The limits of flatness, in a certain proportion of cases, found to vary when the patient assumes different positions. The flatness sometimes found to extend, in front, on the opposite side, even beyond the sternum, in consequence of lateral displacement of the mediastinum. Respiration often suppressed below the level of the liquid effusion; broncho-vesicular or bronchial over the compressed lung. A bronchial respiration sometimes diffused over the chest, but usually feeble and distant, except at the summit. In the latter situation generally discoverable either in front or behind, oftener the latter, varying in different cases as respects intensity and the area over which it is heard. Sounds of heart transmitted to distant parts through the mass of liquid. Friction-sounds occasionally heard in this stage. Increased vocal resonance, sometimes bronchophony, and, as a rare phenomenon, pectoriloquy, discovered at the summit of the chest on the affected side. All these vocal signs may be absent at the summit, and they are all absent, as a rule, over the portion of the side occupied by the liquid. Ægophony present in a certain proportion of cases at a particular and usually a transient period in this stage. Generally, when present, limited to the neighborhood of the inferior angle of the scapula behind, and to a zone extending from this point to the anterior part of the chest; but, exceptionally, in some instances diffused over the whole side. Dilatation of the affected side, commencing below and extending, in some cases, over the entire side; the intercostal depressions effaced, and various alterations in the relations of the external component parts of the thoracic parietes. Dislocation of the heart, and depression of the diaphragm, with subjacent organs, from the pressure of the fluid. Unnatural regularity and smoothness of the surface of the affected side. Fluctuation perceptible to the eye and to the touch in some instances. Comparative immobility of the affected side. Abolition of vocal fremitus below the level of the liquid. Increased respiratory movements and exaggerated vesicular murmur on the healthy side.

Third Period, or Stage of Absorption.—Vesicular or vesiculo-tympanitic resonance on percussion, developed first at the summit and gradually extending downward, but, relatively to the opposite side, persisting dulness. Flatness continuing at the base. Respiration feeble and broncho-vesicular, progressively developed from above downward, gradually assuming the normal vesicular character. Suppression at the lower part of the affected side. Vocal resonance and fremitus absent at the lower part of the affected side, and either wanting or more or less marked above. Ægophony sometimes discovered in this stage. Depression at the summit of the chest, and afterward frequently, if the effusion have been large, marked contraction of the whole side, with changes in the relations of the different external component parts of the thoracic parietes, the reverse of those which have previously existed indicating dilatation. Irregularity of the surface of the affected side. Limited expansive movements. Friction-sounds much oftener discovered in this stage than in the first or second, and in this stage frequently grating or rasping, accompanied sometimes by *tactile fremitus*. Displacement of the heart from the previous pressure of the liquid, or taking place as an effect of absorption. Abnormal elevation of the diaphragm and subjacent organs, after very large effusion, and lateral displacement of the mediastinum toward the affected side.

Chronic Pleuritis.

Chronic pleuritis with copious serous effusion is entitled, clinically, to be considered as an affection distinct from acute inflammation of the pleura, since, it rarely follows or is preceded by the latter. In the majority of cases, the inflammation is subacute from the first. The anatomical conditions, however, so far as concerns their relations to physical signs, are essentially the same as in acute pleuritis after an accumulation of liquid has taken place. The chief point of difference relates to the quantity of effusion. In chronic pleuritis with copious effusion, the quantity commonly attains to an amount which is only occasionally observed, in the acute variety. The clinical history of the former is therefore characterized by the phenomena to which a large accumulation gives rise. When cases of chronic pleuritis present themselves to the physician, they exhibit one of two phases of the affection; and it suffices for practical convenience to consider each phase as a distinct period or stage. The two periods or stages correspond to the second and third of acute pleuritis. The first period or stage of the latter is, in fact, wanting in chronic pleuritis. The first period, or stage, will, then, continue so long as the liquid in the pleural sac is accumulating, or remains stationary. This may be termed the stage of accumulation. The second period or stage extends from the time when the liquid begins to diminish, till its removal is effected; and this may be called the stage of absorption. The first period is frequently of brief duration, but it varies in this respect considerably in different cases. The second period is usually much longer, being rarely limited to a few weeks, and often embracing many months.

Although less frequent in its occurrence than the acute variety, chronic pleuritis is not a very rare affection. It was remarked by Dr. Hope that "there is no class of affections more habitually overlooked by the bulk of the profession than this;" and the previous histories in the cases that have fallen under my observation have afforded evidences of the correctness of the remark.[1] This fact renders the diagnosis a subject of importance. The fact, however, is significant, not of intrinsic difficulties in the way of discriminating the disease, but of the extent to which physical exploration of the chest is neglected. As regards physical signs and the points involved in the diagnosis, they have, for the most part, been embraced in the consideration of acute pleuritis. Inasmuch, however, as familiarity with the phenomena attained by exploration and their combinations is only to be acquired by repetition, a recapitulation of these signs and diagnostic points in the present connection will not be disadvantageous to the student.

Physical Signs.—A patient with chronic pleuritis who comes under observation while the serous effusion is either accumulating or remains stationary at the highest point of accumulation, will be found, in the great majority of cases, to present the physical evidence of a sufficient quantity of liquid in the pleural sac to fill the affected side, compressing the lung into a small space, and frequently the phenomena incident to enlargement and displacement of other intra-thoracic organs are superadded.

The percussion-sound is flat from the base of the chest upward over the whole or greater part of the affected side. A tympanitic resonance may be discovered at the summit, with perhaps an amphoric intonation. The want of elasticity of the thoracic parietes and sense of resistance felt in percussing, are marked.

In the majority of cases, at least in adults, all respiratory sound is suppressed over the greater part, and sometimes over the whole of the affected side. In a small proportion of instances, in adults, a bronchial respiration may be perceived more or less diffused. It is feeble, and conveys the impression of distance, except at the summit. In the infra-clavicular region, in a certain proportion of cases; in the upper scapular region, in a larger proportion; and in the interscapular region commonly, a bronchial respiration may be discovered, more or less intense, and seemingly near the ear. It very rarely, in either of these situations, has that intensity, acuteness, and metallic tone which belong frequently to the bronchial respiration due to lung solidified by tuberculous, and still more by inflammatory deposit. On the healthy side the respiratory murmur is intensified but vesicular, distinguished as exaggerated, puerile, supplementary, or hypervesicular. Greater vocal resonance, and sometimes bronchophony, may be found on the affected side in the interscapular space, and less frequently in the upper scapular and infra-clavicular regions. Elsewhere than at the summit, these vocal signs are wanting. Ægophony is an event of rare occurrence.

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[1] Vide Clinical Report on Chronic Pleurisy, based on an analysis of forty-seven cases, by the author, 1853.

Inspection discovers comparative or positive immobility of the side affected; and on the opposite side the respiratory movements are manifestly increased. The affected side may remain quite motionless, even when the respirations are forced, or there may be a slight and tardy elevation of the ribs. In proportion as the side is but little affected by forced respiration, it is usually enlarged in size. It is distended to quite or even beyond the extreme limit of a voluntary expansion. The ribs are raised, and they approach to a horizontal direction. The lower ribs diverge and the upper converge. The intercostal depressions are effaced, and there may be bulging between the ribs. The nipple is raised, and removed at a greater distance from the median line than that on the opposite side. The side presents an unnaturally regular and smooth appearance. Slight œdematous infiltration beneath the integument of the affected side is sometimes observed. Semicircular measurements with the inelastic tape, applied just below the nipple and the lower angle of the scapula, show an increase of size, varying, of course, not only in different cases, but perhaps at different periods of this stage, the maximum being about two inches. Diametrical mensuration with callipers will also show enlargement between different points.

Palpation, in conjunction with percussion and inspection, shows displacement of movable parts within the chest, in addition to the compression and elevation of the pulmonary organs. The heart, if the left side be affected, is pushed to the right, carried beneath the sternum, and frequently transferred to the right side, being found to pulsate sometimes even beyond the nipple. If the effusion be in the right side, it is elevated and carried in a diagonal direction to the left. The mediastinum is displaced laterally, and flatness on percussion is sometimes discovered not only over the sternum, but for a little distance beyond on the opposite side. The dislocation of the heart will, of course, give rise to dulness over its new situation. Depression of the diaphragm with the viscera in contact with its inferior surface, occasions on the left side extension downward of flatness from the presence of liquid; and on the right side hepatic flatness to an abnormal extent below the ribs, a tumor-like projection caused by the anterior surface of the liver, and a sulcus above due to the convexity of its upper surface. This sulcus, as remarked by Stokes, may after a time be lost, before absorption takes place, in consequence of the convexity of the liver being diminished by pressure.

Fluctuation in the intercostal spaces may sometimes be discovered.

The vocal fremitus natural to the affected side is abolished.

During the second period, the physical signs will present, at successive explorations, repeated at intervals of some duration, variations in degree rather than in kind, according to the rapidity with which the effused fluid is removed. The changes may consist in a gradual return to the normal condition as respects the size, mobility, and relations of the different anatomical parts, internal and external, of the affected side. But it is very rarely if ever the case that a normal condition is recovered, and the natural symmetry of the chest left unimpaired. As the quantity of liquid diminishes, the enlargement of the side decreases, and, at length, it falls within its natural dimensions. Depression of the upper third in front is first observed. This frequently takes place while the semicircular measurement still shows enlargement. Finally, contraction universally of the affected side is a uniform result when the liquid is completely absorbed or reduced to a small quantity. The various phenomena, ascertained by inspection, which are incident to contraction of the chest after the removal of pleuritic effusion, in general terms, are the reverse of those which characterize dilatation. They have already been mentioned in connection with acute pleuritis, and will again be reproduced under the head of the Retrospective Diagnosis of Chronic Pleuritis: they need not, therefore, be here enumerated.

But before marked contraction of the chest takes place, the displaced intra-thoracic organs, especially the heart, retrograde toward their normal situations. And as regards the final disposition of these organs, certain changes are liable to succeed chronic pleurisy, which have been already noticed, inasmuch as they occasionally follow the acute variety of the disease; and these also will be recapitulated presently.

Percussion-resonance, in proportion as the compressed lung undergoes expansion, becomes developed at the upper part of the chest, and extends downward. The affected side over the space occupied by the expanded lung, however, in most instances yields a dull sound compared with the resonance of the healthy side; and if sonorousness be marked, as is sometimes the case, it is vesiculo-tympanitic in quality. The respiratory sound becomes developed, extending lower and lower, but relatively feeble, and with more or less of a broncho-vesicular character. The vocal resonance may be greater or less than on the healthy side. The same is true of vocal fremitus. Friction-sounds are frequently discovered during this stage. They are to be sought for over the middle and lower thirds in front, laterally, and behind. They are often rough and loud. I have known an instance, already referred to, in which they attracted the attention of the patient, continuing when he was able to be up and out of doors. They may be accompanied by tactile fremitus. They persist in some instances for a long period. I have noted their existence in a case ten months after the date of the commencement of the disease.

Ægophony is sometimes discovered during the progress of absorption.

The period occupied by the successive and progressive changes indicating the diminution and removal of the liquid effusion in chronic pleuritis, as already stated, is variable, but in most cases it extends over several months.

Diagnosis.—So far as the symptomatology of the disease is concerned, irrespective of the physical signs, chronic pleuritis is often remarkably latent. Excluding the small proportion of cases in which it is preceded by acute pleuritis, the development of the affection is very rarely attended by severe pain, and frequently this symptom is entirely wanting. In obtaining the previous history, the fact of pain having existed would often escape notice without careful inquiry, the attention of the patient being at the time scarcely attracted to it, and its occurrence forgotten. When cases come under observation after the disease has existed for several weeks, absence of pain is the rule. Cough and expectoration are sometimes wanting, and are rarely prominent. As a rule, these symptoms do not precede the development of chronic pleuritis except they depend on antecedent pulmonary tuberculosis. When cough is present it is generally either dry or accompanied by a small expectoration, which consists of mucus more or less modified. The sudden occurrence of a copious sero-albuminous or puruloid expectoration, continuing for a greater or less period, indicates ulcerative perforation of the pleura commencing within the sac, and establishing a communication with the bronchial tubes. This accidental event gives rise to pneumo-hydrothorax. The respirations are usually increased in frequency, but to this rule there are exceptions, even when the accumulation of liquid is sufficient to remove the heart to the right of the sternum. The increase in frequency is rarely great while patients are tranquil. Exercise or the use of the voice in conversation furnishes the evidence of want of breath. Under these circumstances dyspnœa, with lividity of the prolabia, may be produced, which is rarely observed while patients are at rest. The pulse in the majority of cases is more or less accelerated, ranging from 80 to 120 per minute; but I have observed it to be even below the normal average, viz., 64 per minute. Sweating frequently occurs at night, not uniformly preceded by a febrile paroxysm or exacerbation. Chills or chilly sensations from time to time are apt to occur, even when the disease is simple, *i. e.* not complicated with tuberculosis, and also when the liquid contained in the chest is not purulent. The digestive functions may be more or less disordered, but in some instances the appetite is good, and the ingestion of food occasions no disturbance during the whole progress of the disease. Pallor of the countenance is marked in some cases, but in others the aspect is not notably morbid, although the chest be filled with liquid effusion. In a large proportion of cases, if the disease be uncomplicated, the progress of the affection is not attended by great loss of weight or emaciation. The strength is sometimes preserved in an astonishing degree. I have known instances in which the disease was allowed to pursue its course without receiving any medical treatment, the patients prosecuting most of the time laborious occupations. The diagnosis in these cases was, of course, made retrospectively. It is not uncommon for cases to come under observation when the disease has existed for several weeks or even months without any previous application having been made for medical aid; little or no inconvenience having been experienced except from want of breath in active exercise. Employments involving violent exertions, such as chopping and sawing wood, stone-cutting, the duties of a house-maid of all work, and active participation in the rough out-door sports of youth, have been continued in cases that have fallen under my notice when the chest was filled with liquid, which, under these circumstances, has progressively diminished by absorption.[1]

The symptoms of chronic pleuritis embracing so little that is distinctive, not only is it confounded with other pulmonary diseases, especially phthisis, by those who do not avail themselves of physical exploration, but frequently even the existence of a pulmonary affection is not suspected. Latent intermittent fever, bilious fever, dyspepsia, general debility, disease of heart, and the ideal affection called "liver complaint," are the maladies under which patients have been supposed to labor in cases that have fallen under my observation.

To determine the existence of the disease with the aid of physical signs is generally one of the easiest problems in diagnosis. I have, however, known the phenomena to be attributed to hepatization of lung by those who had given some attention to the exploration of the chest. Circumstances pertaining to the physical signs suffice for the discrimination between the presence of an abundant effusion and the solidification from pneumonitis. The points involved in this discrimination have already been presented in connection with acute pleuritis, and need not be recapitulated. But in view of the previous history, when flatness is found to extend more or less over the chest in cases of chronic pleuritis, pneumonitis is almost excluded by the law of probabilities alone. Antecedent acute inflammation of the pulmonary parenchyma would be evidenced in the vast majority of instances, by rational symptoms having occurred which do not accompany the development of chronic pleuritis, viz., pain, rusty expectoration, febrile movement, and confinement to the bed for a certain period. But, irrespective of this point, the existence of chronic pneumonitis, either as a sequel of the acute form of the disease or as a primary affection, is exceedingly improbable.

The affections which may give rise to phenomena closely analogous to those belonging to chronic pleuritis, are infiltrated cancer of the lungs and mediastinal tumor. These affections are much less frequent in their occurrence than chronic pleuritis, and the liability, therefore, to error, is in attributing their phenomena to the latter affection; in other words, to suppose that chronic pleurisy exists, when they are present. The liability to this error is somewhat increased by the fact that in both these affections pleuritic effusion is apt to occur. Infiltrated cancer of the lung produces contraction of the affected side of the chest. Mediastinal tumor, on the other hand, may lead to dilatation. In the first instance, the disease may be mistaken for pleuritis advanced to the second period, or the stage of absorption. In the second instance, pleuritis in the first period, or stage of liquid accumulation, may be supposed to exist. The points involved in the differential diagnosis from these affections have been already noticed in the preceding chapter, under the heads of Cancer of the Lungs, and Cancer in the Mediastinum. A brief reference to them will be all that is requisite in this place.

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[1] The rate of mortality from uncomplicated chronic pleurisy in my experience is about 17 per cent.

A cancerous affection of the lungs or mediastinum (and it may coexist in the two situations) is more uniformly accompanied by cough and expectoration than chronic pleuritis. The expectoration is more abundant, becoming purulent, and is frequently characteristic, resembling red or black currant jelly. Hæmoptysis is an event of frequent occurrence. Pain is a more prominent and persisting symptom. The pulse, on the contrary, is less commonly accelerated until the affection is quite advanced. The contraction of the chest, produced by the absorption of the liquid effusion in chronic pleuritis, is usually greater than in cases of infiltrated cancer. In the latter affection, the loss of strength, emaciation, and pallor, denote a graver malady than uncomplicated chronic pleuritis.

Cancer in the mediastinum frequently extends more or less into both sides of the chest, giving rise, of course, to flatness on percussion and other physical phenomena, not limited to one side, as in cases of chronic pleuritis. Effacement of the intercostal depressions, and a sense of fluctuation, may be produced by the pressure of a tumor, but only in rare instances, while these effects are common when the side is dilated by the presence of liquid. The dilatation from a cancerous or other tumor is often partial or circumscribed, irregular, and extends from above downward; while in the stage of accumulation, in chronic pleuritis, it becomes general, extending from below upward, and the enlargement is more regular. Dyspnœa is a more constant and prominent symptom, in cases in which a tumor exists of sufficient size to occasion a considerable dilatation of the chest. In both diseases, the heart and diaphragm, as well as the lung, are subject to displacement. But when this occurs from the pressure of a tumor, certain symptoms are frequently superadded to those incident to an equal amount of displacement from the accumulation of liquid; viz., œdema of the face, lividity, swelling of the veins, dysphagia, as well as marked dyspnœa. These symptoms are due to pressure on the air-tubes, large vessels, nerves, and œsophagus; and liquid accumulation in the pleura, however large, never produces an amount of pressure on these parts, equal to that which results from a large mediastinal tumor. The symptoms, therefore, just mentioned, are distinctive of the latter.

Reverting to physical signs, in cancer of the lungs or in the mediastinum, the bronchial respiration and increased vocal resonance, or bronchophony, are often found over the parts of the chest, where the percussion-sound is dull or flat. These are eminently the signs of pulmonary solidification. On the other hand, in chronic pleuritis, absence of respiratory murmur and abolition of vocal resonance, below the level of the liquid, is the rule; the reverse occurring in only exceptional instances. Absence of respiratory and vocal sound, with flatness on percussion, is a combination of signs eminently distinctive of the presence of liquid. Vocal fremitus may be preserved or increased in cases of cancerous infiltration or tumor. It is uniformly abolished below the level of the liquid, in chronic pleuritis. In the former affections, we may expect often to find vesicular resonance on percussion, at or near the base of the chest, below the limit of dulness or flatness. In chronic pleuritis, in all save some very rare instances, we find flatness from the base of the chest extending more or less upward.

The distinctive circumstances involved in the differential diagnosis of chronic pleuritis from cancer in the mediastinum are applicable, in a great measure, to the discrimination in cases of intra-thoracic tumor, arising from any other part exterior to the lungs.

RETROSPECTIVE DIAGNOSIS OF CHRONIC PLEURITIS.

Cases not infrequently are presented in practice in which it is important to determine, from an examination of the chest, whether chronic pleuritis have existed at some former period. A sense of weakness in the chest, and some deficiency of breath on active exercise, are apt to remain for a long time after recovery—that is, after the liquid effusion is completely absorbed, and there are no other symptoms which denote any pulmonary affection. Instances of this description have come under my observation, in which patients had experienced the disease several years before, its character, perhaps, at the time, not having been determined. In other cases there are present symptoms which may be due to some existing affection of the lungs, and in endeavoring to ascertain its nature, the permanent changes which have resulted from the pleuritis, must be taken into account. Chronic pleuritis may lead to certain consecutive affections. Dilatation of the bronchial tubes has been observed to follow. Emphysema may be a result. It has been supposed to increase the liability to pulmonary tuberculosis. Statistics show this opinion to be incorrect;[1] but phthisis, of course, supervenes in some instances, and it is not infrequently an important problem to solve, in individual cases, whether this be so or not; a problem which, as has been seen already, is rendered more difficult by the changes consequent on the absorption of a large pleuritic effusion. The retrospective diagnosis of chronic pleuritis, therefore, is a subject which appears to me deserving of separate consideration.

The diagnosis is made retrospectively by means of the remote or permanent effects of the disease. These are essentially the proximate effects, which do not entirely disappear for an indefinite period, or even during the remainder of life, and they have already been adverted to. They consist in contraction of the chest, alterations in the relations of different anatomical parts on the exterior of the thoracic parietes, displacement, in some instances, of intrathoracic organs, and variations in percussion, respiratory and vocal sounds—in short, disturbance of the natural symmetry of the two sides of the chest, as respects the results furnished by the different methods of physical examination. This disturbance of symmetry, presenting characters which, collectively, are highly significant of the pre-existence of chronic pleuritis, justify a retrospective diagnosis. For what length of time after recovery is this diagnosis practicable? This will, of course, depend on the persistency of the characters just referred to. The period doubtless varies in different cases. The changes immediately succeeding the disease gradually diminish, and examinations repeated at long intervals show progressive advancement toward restoration of the natural symmetry. Much will depend on the extent of the proximate effects. The age of the patient will also affect the final condition. In proportion to youth, other things being equal, will be the ultimate approximation to the normal symmetry. But it is probable that in many, if not most instances, characters sufficient for a retrospective diagnosis remain during life. I have preserved notes of two examinations made ten years after recovery, and in both the traces of the disease were strongly marked. The brief account which I shall give of the remote effects on which the retrospective diagnosis is to be based, will be derived from the recorded results of fifteen examinations of different patients, made at periods varying from ten months to ten years from the date of the attack. In all these cases recovery had taken place, and the patients (all of them adults), so far as could be judged from the symptoms and signs, were free from existing pulmonary disease.[1]

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[1] Vide "Practical Observations on Certain Diseases of the Chest, etc By Peyton Blakiston, M.D." Am. Ed. 1848. Also, "Clinical Report on Chronic Pleurisy," by author.

Of fourteen cases in which either the existence or non-existence of diminished width of the chest was noted, it had occurred in all save two, and in these two instances there was flattening of the summit. In one case, at the summit of the affected side, instead of depression, there was greater comparative fulness; and this, coexisting with a clear, vesiculo-tympanitic percussion-resonance, and feebleness of the respiratory murmur, rendered it probable that emphysema had become developed in that situation. In the two instances in which diminished width was not apparent, the examinations were made in one ten months, and in the other three years from the date of the disease. The relative measurements of the semi-circumference of the two sides were noted in six cases. In these cases the contraction varied from half an inch to one and a half inches, always allowing for the right side half an inch as a normal disparity. The comparative contraction of the affected side after pleuritis is partly absolute and in part relative, the opposite side augmenting in size from the hypertrophy of lung resulting from the supplementary increase of the respiratory movements. The disparity between the two sides which immediately follows absorption, gradually becomes less, especially if the patient be young. For example, in a case attended with large effusion, removing the heart to the right of the sternum (the left side being affected), the contraction after recovery was strongly marked. In the space of four years, the contracted side had expanded so as to leave but a slight apparent difference. A similar change, after the lapse of two years, I have noted in another case. In both instances the patients were young.

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[1] Two cases are to be excepted from this remark, in one dilatation of the bronchial tubes, and in the other partial emphysema being supposed to exist.

Of fourteen cases the shoulder was depressed in all but three. In one instance it was slightly elevated on the affected side.

Of five cases in which the vertical position of the nipple was noted, it was lowered in four and raised in one. In one instance it was an inch lower than its fellow.

Its distance from the median line was noted in three cases, and in all it was nearer, the difference varying from a quarter of an inch to an inch.

The distance between the lower ribs was compared on the two sides in three cases, and in all it was diminished on the affected side. In one instance the ribs approximated so as almost to overlap. In this case there existed a deep depression on the inferior anterior surface of the chest. In two instances the upper ribs were compared in this respect, and found to be divergent on the affected side.

In nine cases the comparative width of the interscapular spaces was noted, and in eight it was lessened on the affected side. In one instance it was one-half less on that side than on the other. The difference was in no case less than one and a quarter inches. In the single excepted instance in which the width was greater on the affected side, this was evidently owing to the existence of spinal curvature, the convexity looking to the opposite side. Projection of the lower angle of the scapula existed in all the cases in which the facts with respect to this point were noted, viz., in four; the same remark will apply to lowering of the scapula, which was noted in four cases.

Of fourteen cases in which the results of a comparison of the breathing movements on the two sides were noted, in all save one they were more or less diminished on the affected side. This comparative diminution was evidently in a measure due to an exaggerated expansibility on the opposite side.

Dulness on percussion, as compared with the resonance on the side not affected, existed in every instance in which information relative to this point was noted, viz., in thirteen cases.

Great clearness of the percussion-resonance was uniformly observed on the opposite side, and this contributed to render the contrast between the two sides more striking.

Feebleness of the respiratory sound over the whole of the affected side existed in eleven of thirteen cases. This was rendered more marked by an unusual intensity of the vesicular murmur on the opposite side. In one of the two excepted cases, bronchial respiration on the affected side behind, below the scapula, existed, in conjunction with marked bronchophony, the respiration being broncho-vesicular, and the vocal resonance comparatively feeble over the scapula. This combination of signs rendered the existence of dilatation of the bronchial tubes probable. In the other case, bronchial respiration and bronchophony existed in the interscapular space on the affected side. The respiration was interrupted on the affected side, at the summit, in one instance. In five cases the respiratory sound presented certain of the characters of the broncho-vesicular respiration, consisting either in the diminished vesicular quality, with elevation of pitch of the inspiration, or a prolonged expiration. The absence of these characters in the other cases is not always stated.

The results of a comparison as respects vocal resonance are given in ten instances. In six of these cases the resonance was greater on the affected side; but of these six cases, in three, the right side was the one affected. On the other hand, the four cases in which the vocal resonance was not greater on the affected side, included two in which the left side was the one affected.

Of six cases in which the vocal fremitus on the two sides was compared, in four it was greater on the affected side, and in three of these four instances the left side was the one affected.

The situation of the apex impulse of the heart was noted in seven cases. It was normal in three instances. In the remaining four instances the facts were as follows: in two cases an impulse was perceptible between the third and fourth, and also between the fourth and fifth ribs. In one of these instances it was noted that the movements in these two situations were in alternation ("*quasi* undulatory"). In both the left side was the one affected. In one instance the impulse was on a line with the nipple, and one and a half inches below it. In the other case a diffused pulsation was apparent over an area three inches in diameter, situated above the nipple. In the two last instances the left side was the one affected.

Curvature of the spine was noted in four of seven cases. In three instances the curvature was lateral, and in one instance in an anterior direction, causing the patient to assume a stooping gait.

The foregoing results are not given as embracing data sufficient for determining the numerical ratio in which the several changes respectively occur. This would be an interesting object of inquiry, and I regret that I have not availed myself of the opportunities that have been presented, to accumulate materials for an analysis with reference to it. In the few cases analyzed, it will be observed that pains were taken to note facts respecting all the points in a small proportion only, the attention, in most instances, being limited to obvious contraction, a comparison of the expansibility, the percussion-sound, and the intensity of the respiratory murmur. The results, however, are adequate to show the group of characters by means of which the retrospective diagnosis is to be made, for many months or years after recovery from chronic pleurisy. This is the only purpose I have had in view, and these characters, recapitulated, are embraced in the summary which follows.

SUMMARY OF CHARACTERS INVOLVED IN THE RETROSPECTIVE DIAGNOSIS OF CHRONIC PLEURISY.

Diminished width of the chest, apparent on inspection in the great majority of cases. Depression or flattening at the summit of the affected side, almost invariably observed; but occasionally enlargement, which probably denotes abnormal dilatation of the cells, or emphysema. The reduction in size also shown by mensuration. The shoulder generally depressed; but in some instances this is not apparent, and it may be even raised above the level of that on the opposite side. The nipple usually depressed, but not invariably, and nearer the median line. The lower ribs converging, sometimes almost overlapping; the upper ribs diverging. The distance from the posterior margin of the scapula to the spinal column lessened, often in a notable degree; an exception to this rule obtaining, in some instances, when lateral curvature of the spine takes place, the concavity looking toward the affected side. Projection of the lower portion of the scapula, occurring in a certain proportion of instances; and, also, depression of the inferior angle below the level of that on the opposite side. The respiratory movements almost uniformly diminished in a degree more or less marked; the expansibility on the opposite side being, at the same time, exaggerated. Comparative dulness on percussion; the contrast rendered more striking by the great clearness of the percussion-resonance on the opposite side. A vesiculo-tympanitic resonance at the summit, conjoined with enlargement, denoting the supervention of emphysema. Feebleness of respiratory sound over the entire side, with few exceptions; and on the opposite side, an unusually intense vesicular murmur. A bronchial respiration sometimes observed in the interscapular space, and in other parts of the side. In the latter, especially if associated with bronchophony, probably denoting dilatation of the bronchial tubes. The respiration, in a certain proportion of cases, broncho-vesicular. The vocal resonance sometimes greater, but not uniformly. The same remark applicable to vocal fremitus. Curvature of the spine in some cases, the inclination usually lateral, the concavity toward the affected side. The position of the heart frequently normal, but in some instances displacement of this organ; it being found to the left of its natural position and elevated, if the pleuritis be seated in the left side.[1]

It will be borne in mind that this summary embraces characters observed in persons after complete recovery from chronic pleuritis, and presumed to be entirely free from any existing pulmonary disease, excepting, in some instances, emphysema and dilatation of the bronchial tubes.

EMPYEMA.

When the liquid contents of the pleura are purulent, the affection is generally called *empyema;* a better term, used by some writers, is *pyothorax.* Empyema is, in fact, only a variety of pleuritis; but in view of certain pathological peculiarities, there is a propriety in considering it as a distinct form of the disease. Inflammation, either acute or chronic, in this, as in other situations, evinces in some instances a peculiar tendency to the formation of pus. This tendency is independent of the intensity, nor does it depend on the duration of the inflammation or the amount of effused products. The symptoms denoting a high grade of inflammatory action may be equally absent when the chest is filled with purulent matter, as in ordinary cases of chronic pleuritis; and death may occur with an accumulation of pleuritic effusion of long standing when the chest contains only serum and lymph. Empyema, therefore, seems to be a species of pleuritic inflammation differing from ordinary pleuritis, *ab initio*, in a tendency to the formation of pus.

Clinically, however, it is by no means easy to distinguish empyema from ordinary chronic pleuritis, and, indeed, a positive discrimination by means of the symptoms and signs is impracticable. The physical phenomena in both are equally those which are due to an accumulation of liquid. There are none which are distinctive of the character of the liquid. Bulging between the ribs, which has been supposed to indicate the presence of pus rather than serous effusion, depends on the quantity of liquid, together with a condition of the intercostal spaces which renders them yielding to pressure, and is significant alike of both varieties. The occurrence of hectic paroxysms, of more marked and persisting febrile movement, or greater gravity of the local and general symptoms, cannot be relied upon. I have known the fact of an enormous accumulation of liquid, which was found to be purulent, to be discovered accidentally only a few days before death. Cases of empyema, as well as of ordinary chronic pleuritis, are liable to be overlooked, patients being able to go about, and supposed to labor only under general debility, or some malady not seated in the chest. Such instances have fallen under my notice.

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[1] The liability of the heart to be permanently drawn toward the right side after pleuritis affecting that side, has been already adverted to.

Assuming it to be determined that the pleural sac is more or less filled with liquid, a point which, as has been seen, by means of physical exploration, may be settled with promptness and certainty, it is highly desirable, with reference to the prognosis and the management, to decide, if possible, whether the liquid be purulent or not. A rational conclusion may be formed with considerable confidence if, the quantity of liquid being large, it remains stationary, and, more especially, if it continue to increase, in spite of judicious therapeutical measures to promote its diminution by absorption. In the great majority of cases of ordinary chronic pleuritis these measures are, to a greater or less extent, successful: the amount of fluid is reduced, although, after a time, its farther reduction may not be effected. A purulent fluid being with more difficulty absorbed, it is much more likely to remain undiminished or to increase. As regards the relative quantity of liquid at different periods, this can of course be ascertained with precision by repeated explorations.

But although the physical signs and symptoms are not adequate to afford positive information as to the character of the liquid contained in the pleura, this point may be settled readily and demonstratively by a method involving little or no difficulty or danger. I refer to the use of the exploring canula. The cases reported within the past few years by Dr. Bowditch, of Boston, in which *paracentesis thoracis* was performed after the plan proposed by Dr. Morrill Wyman, of Cambridge, Mass.,[1] show that the operation may be resorted to with ease and safety, in order to determine the nature of the liquid contents of the chest.

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[1] Vide Am. Jour. of Med. Sciences, April, 1852. The method referred to consists in using a small canula, which is attached by a flexible tube to a suction-pump, so constructed that the fluid may be removed from the chest through the canula, and discharged from the pump through another aperture.

To discuss the merits of this operation, as of other therapeutical measures, does not fall within the scope of this work. With reference to its performance, the importance of being able, by means of physical signs, to determine positively the presence of effusion, is sufficiently obvious. Heretofore the question as to the propriety of resorting to this operation involved the liability of mistaking ordinary pleuritis or empyema for other affections; and the operation has frequently been performed when there was no liquid within the pleural cavity. An instance of this kind has occurred within my own knowledge. Uncertainty in diagnosis is no longer a valid reason either for omitting or delaying to puncture the chest.

It is chiefly in cases of empyema that the contents of the pleural sac are discharged spontaneously, by means of ulceration and a fistulous communication, either directly through the thoracic parietes, or indirectly through some natural outlet. The evacuation may take place through the bronchial tubes, which occurs next in frequency to perforation of the walls of the chest. It has been known to take place into the alimentary canal. The sudden occurrence of a copious purulent expectoration, when the chest is known to contain liquid, is evidence that ulceration has ensued, commencing from within the pleural sac; but the phenomena arising from the presence of air and liquid in the cavity of the pleura are speedily superadded;—the affection, in short, becomes pneumo-hydrothorax.

When perforation of the thoracic parietes occurs, the purulent fluid collecting beneath the integument forms a fluctuating tumor, evidently situated exterior to the bony wall of the chest. If the preexistence of an accumulation of liquid has not been ascertained, this tumor may be regarded as simply an abscess, not communicating with the interior of the chest. I have known this mistake to be committed by those who were not accustomed to employ physical exploration. The coexistence of the physical signs of a large accumulation of liquid in the pleural sac, renders the connection of the subcutaneous collection with empyema altogether probable. But this connection may be established by compression of the tumor. If it be simply an abscess beneath the integument, it is irreducible by pressure; but if the fluid be derived from the chest through a perforation, it may be made in a great measure to disappear, by forcing its contents into the thoracic cavity. Again, a tumor containing a fluid which communicates freely with liquid in the chest, will be observed to rise and fall with the successive acts of inspiration and expiration. Moreover, an abscess developed exterior to the chest would involve, generally at least, acute inflammation, accompanied by pain, swelling, heat, and redness, prior to fluctuation. These local phenomena do not precede the appearance of a fluctuating tumor, due to perforation in the course of empyema. If the tumor be opened, under the erroneous impression that it is nothing more than a subcutaneous abscess, the great abundance of the purulent discharge will be likely to lead to a discovery of the error.

A fluctuating tumor beneath the integument, due to perforation in empyema, is sometimes found to pulsate synchronously with the beating of the heart. This may, at first, excite a suspicion of aneurism. The tumor is too rapidly developed, its liquid contents are too superficially situated, and the fluctuation too marked and extensive, to be aneurismal. The positive signs of aneurism are wanting, viz., the bellows' murmur and thrill; and the physical signs of an abundant accumulation of liquid in the chest remove all doubt as to its character.

A pulsation is occasionally observed more or less diffused over the affected side, in cases of empyema, in which the liquid is retained within the pleural sac. This gives rise to a variety of the disease which has been called *pulsating empyema.* An instance has fallen under my observation, in which the shock communicated to the walls of the affected side led the attending physician to suppose that the case was one of disease of the heart.[1] Moderate hypertrophy of the left ventricle actually existed, as ascertained after death. The circumstances, in such instance, which authorize the exclusion of aneurism are the absence of its positive signs furnished by auscultation and palpation, viz., the bellows' murmur and thrill, together with the absence of the symptoms due to the pressure of an intrathoracic tumor on the vessels, nerves, œsophagus, and air-passages—symptoms not belonging to the clinical history of liquid accumulation in the pleura, however large. Taken in connection with these negative points, the physical signs of a large quantity of liquid in the chest establishes the diagnosis.

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[1] Clin. Report on Chronic Pleuritis, p. 47.

CIRCUMSCRIBED PLEURITIS, WITH LIQUID EFFUSION.

Circumscribed inflammation of the pleura, either without much liquid effusion, called dry pleuritis, or the effusion not confined within the limits over which the inflammation extends, occurs as a complication of other pulmonary affections, and has already been noticed in connection with pneumonitis and pulmonary tuberculosis. But pleuritis may be partial or circumscribed, and accompanied by more or less effusion of liquid, which is not diffused, and does not gravitate to the bottom of the sac, but is retained by adhesion at the borders of the area of the inflammation. Under these circumstances, the fluid is, as it were, encysted, occupying between the pleural surfaces a circumscribed space, varying in size and in situation. In some instances there exist several distinct collections of liquid, constituting, if the fluid be purulent, what has been denominated *multilocular empyema.* The latter variety, as well as that in which the affection is *unilocular,* occurs in persons who have previously had general pleuritis, followed by general agglutination of the pleural surfaces, more or less extensive, leaving one or more spaces in which the surfaces did not adhere. Subsequent attacks of inflammation limited to the non-agglutinated portions of the membrane, constitute circumscribed pleuritis, accompanied by an effusion restricted within the boundaries of the space or spaces in which the surfaces are free.

These local collections of liquid may occur in different situations. They may be seated between the diaphragm and the base of the lung, or at any point between the costal and pulmonary portions of the pleura, on the anterior, posterior, or lateral surfaces, and they have been known to take place between the lobes, the latter having become adherent at the margins of the interlobar fissure. Circumscribed inflammation, in these different situations respectively, is distinguished as costo-pulmonary, diaphragmatic, and interlobar pleuritis.

If acute inflammation be seated in the diaphragmatic pleura, certain symptoms are pointed out as somewhat distinctive, viz., severity of pain, forward inclination of the body, cough remarkably paroxysmal, predominance of the superior costal type of breathing, hiccough, nausea, and vomiting, jaundice if the right side be affected, and sometimes the *risus sardonicus.*[1] It may be doubted if these symptoms possess much diagnostic value. They are, however, worthy of being borne in mind, the more because the existence of a circumscribed collection of fluid between the diaphragm and the base of the lungs is detected by means of physical signs with much greater difficulty than in other situations. In fact, when an accumulation exists in this part of the chest, if small or moderate in amount, a positive diagnosis is hardly attainable. Even with the advantage of the occurrence of perforation of the lung and the discharge through the bronchial tubes of purulent matter, assuming that tuberculosis and pulmonary abscess are excluded by the negative results of physical exploration, it may be difficult to determine whether the collection of pus has taken place above the diaphragm or in a subjacent organ. A case which came under my observation several years ago, will serve to illustrate this difficulty. A patient entered a hospital with a copious expectoration, apparently of pure pus, which had existed for some time. Ten ounces were expectorated in the space of twenty-four hours. He was not much emaciated; the pulse was 72; the respirations 24; moderate diarrhœa existed, and it was reported that the dejections sometimes contained pus; but the latter point was not satisfactorily ascertained. Physical exploration furnished the following results. Emaciation not sufficient to render the outline of the ribs visible. Clear percussion-resonance at the summit of the chest on both sides. Flatness on the right side from the base to the fourth rib in front. Behind, in the interscapular space, resonance clear on both sides. Flatness below the inferior angle and over the lower part of the right scapula. Tenderness on pressure at the lower part of the right side, extending below the boundary of the chest. Respiration on the left side exaggerated; on the right side, above the fourth rib feeble, but vesicular; below the fourth rib absence of respiratory murmur, and a distinct, but not loud friction-sound with both respiratory acts. Behind, on the right side, respiration feeble, bronchial, and accompanied by a fine mucous or sub-crepitant rale. Bronchophony at the angle of the scapula.

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[1] Walshe, op. cit.

After the death of this patient, it was ascertained that a pleuritic abscess, as it may be called, was situated at the lower part of the right side of the chest. Circumscribed inflammation, the pleural surfaces being free, existed over a strip five or six inches in width, at the base of the chest, extending from the lower part of the sternum quite around the right side. Above this strip the pleural surfaces were agglutinated. The lower lobe of the right lung was solidified; otherwise the pulmonary organs were free from disease.

The situation of the circumscribed empyema, in this case, accorded with the physical signs; yet, in view of all circumstances, there being no evidence of general chronic pleuritis or empyema having existed, and balancing probabilities, hepatic abscess, evacuating through the lungs, had been suspected.

In the diagnosis of circumscribed collections of liquid situated between the costo-pulmonary pleural surfaces, elsewhere than at the base of the chest, physical signs are more available. Dulness or flatness on percussion will be found over a space corresponding to the area within which the liquid is confined. Effacement of the intercostal depressions and even bulging may be observed in this space. The vocal fremitus may be wanting. The respiratory sound may be feeble or absent, together with abolition of vocal resonance. Surrounding the collection, owing to the pleuritic adhesions and condensation of lung, the respiratory sound will be more or less developed and broncho-vesicular. The signs just mentioned will be especially marked in cases in which the area of pleuritic surface occupied by the effusion, and the quantity of the latter, are not small; and the diagnosis is made with more positiveness if the situation of the collection be in the middle third of the chest, and if there are present the evidences of general pleuritis having existed at some former period.

If circumscribed pleuritis exist with a fistulous opening through the thoracic wall, the probe becomes an important instrument in diagnosis. An interesting case of this description, of traumatic origin, was recently under my observation through the kindness of my friend and colleague, Professor Gross. The patient, three months before, had received a wound from a hatchet, penetrating the chest on the left side, between the first and second ribs, about three inches from the median line. Acute general pleuritis followed; but he was now able to be up and about, presenting a healthy aspect, free from cough or difficulty of respiration, except after active exercise. The left side was considerably contracted. A small fistulous opening existed at the place where the wound was received, from which about a table-spoonful of puriform liquid escaped daily. To evacuate the fluid, which he was accustomed to do twice daily, he was obliged to lie upon the floor with his face downward, and the body inclined to the left. A probe introduced into the orifice showed the existence of a circumscribed cavity, the vertical length being about five inches, and the orifice near its upper extremity. On forced expiration, air was expelled through the aperture with an audible noise; and the patient stated that sometimes when the orifice was first opened by detaching the incrusted lymph with which it became sealed, the passage of the air occasioned a loud report.

To prevent the accumulation of liquid in the cavity, Professor Gross penetrated it with a trochar at its lower extremity, and established, by means of a tent, a fistulous orifice in this situation. This treatment speedily effected a cure, the cavity becoming obliterated in a few weeks.

The existence of several, or multilocular, collections was presumed in a case which came under my observation five years since, of which the following is a brief account. The patient, a girl fourteen years of age, had been subject for several years to a loud, hard cough, with a small, transparent, frothy expectoration. Five weeks previous to the date of my examination, she had suddenly expectorated a quantity of purulent matter. She continued to expectorate the same matter for a day or two, and it then ceased. Afterward, during the five weeks, she had several similar attacks. The general health was not much impaired. On examination of the chest, there was moderate dulness on percussion at the summit of the right side, with no distinct abnormal modification of the respiratory sound. Absolute flatness existed over the lower and most of the middle third on the right side, with absence of respiration in front and laterally. Behind, on the right side, the percussion-resonance was clear to the base. No rales, nor either bronchial or cavernous respiration. Tenderness on percussion was observed over the right mammary region. Nine months afterward, this patient seemed quite well, but on slight examination flatness over the lower part of the chest on the right side still existed. She had at that time had no purulent expectoration for some time.

Interlobar pleuritis with liquid accumulation presents difficulties in the way of diagnosis still greater than when the collections are situated between the costo-pleural surfaces. The pressure of the liquid here is not directly upon the thoracic parietes. Pulmonary substance, more or less compressed, intervenes between the liquid and the walls of the chest. The percussion-resonance will, therefore, be more or less dull, but not flat; and effacement of the intercostal depressions, or bulging, will not be likely to occur. The respiratory sound will be feeble and more or less broncho-vesicular, or even bronchial, from the presence of condensed lung. Dr. Walshe mentions the fact of the accumulation being in the line of the interlobar fissure, as a point having a bearing on the diagnosis.

Circumscribed pleuritis with liquid effusion is by no means of frequent occurrence. It is only now and then that cases occur to puzzle the diagnostician.

HYDROTHORAX.

Serous effusion within the pleura, not due to inflammation, constitutes the affection called hydrothorax. The effusion is purely serous, *i. e.* serum unmixed with inflammatory products. The affection is never primitive or idiopathic. It occurs always as an effect or complication of some other disease; and in the great majority of cases it coexists with general dropsy incident to structural lesions of the heart or kidneys.

The diagnosis claims but a few words. Its pathological connections constitute a diagnostic point. We look, as a matter of course, for more or less effusion into the chest in cases of cardiac or renal dropsy. The affection is always double. The causes act equally on both sides, their *modus operandi* being purely mechanical. For this reason it is impossible that the quantity of effusion should ever be sufficient completely to fill the chest. A near approach to this amount of accumulation in both sides would be incompatible with life. And in consequence of the affection being double, a moderate amount of effusion is productive of far greater disturbance of the respiratory function, as induced by accelerated breathing, dyspnœa, lividity, etc., than belongs to cases of chronic pleuritis in which the whole of one side is filled with liquid. Moreover, the pathological conditions associated with hydrothorax, such as ascites, hydro-pericardium, organic disease of heart, general debility, render the system less able to bear up under a diminution of the respiratory function, than in the majority of cases of chronic pleuritis.

Except in degree, the positive symptoms offer nothing distinctive of hydrothorax. Negatively it is distinguished from pleuritis by the absence of the symptomatic phenomena due to inflammation, viz., lancinating pain, tenderness on pressure, and cough. These phenomena, present to a greater or less extent in many cases of pleuritis, are wanting in hydrothorax, or, at least, do not constitute a part of its semeiological history.

The physical signs representing a certain quantity of liquid in the pleural sac, displacing the lung, perhaps occasioning some enlargement of the inferior portion of the chest, and depressing the diaphragm, are essentially the same in hydrothorax as in pleuritis. It is unnecessary to recapitulate them in this connection. There are, however, certain distinctive points pertaining to the physical phenomena, which possess diagnostic significance. The visible changes in size, form, and expansibility, resulting from a very large accumulation of liquid, which are observed in cases of chronic pleuritis, are of course never exhibited in cases of hydrothorax, because a similar amount of accumulation in both sides is incompatible with life. This has less clinical value as a distinctive feature than those which remain to be mentioned. In hydrothorax, friction-sounds do not occur. The condition for their production, viz., roughening of the pleural surfaces by a deposit of lymph, is incident to inflammation, and does not obtain in a purely dropsical affection. This is a negative point. A positive point is, that in cases of non-inflammatory serous effusion, the liquid, as a rule, if not invariably, can be made to change its level by varying the position of the patient; the quantity of liquid never becoming very large, and the pleural surfaces remaining free, this test of the existence of effusion is always or generally available, while in pleuritis it is employed successfully in a certain proportion of cases only.

The points thus briefly adverted to, pertaining to the symptoms and signs, taken in connection with the existence of effusion on both sides, and the fact that the affection occurs only as a complication of other diseases, which give rise at the same time to general dropsy, render the diagnosis of hydrothorax easy and positive.

PNEUMOTHORAX—PNEUMO-HYDROTHORAX.

An abnormal condition, consisting in the accumulation of air or gas within the pleural sac, unaccompanied by liquid effusion, is denominated *pneumothorax*. Thus defined, the affection may be said to be almost infinitely rare. The secretion or exhalation of air or gas from the pleural surfaces, must be regarded as extremely problematical. Pleural rupture over the dilated cells in vesicular emphysema, or of the blebs which are occasionally formed in the interlobular variety of this disease, is an accident which has been known to occur in a few instances, giving rise to an accumulation of air in the pleura, unaccompanied, for a time, at least, by any morbid product; but, under these circumstances, inflammation is likely soon to supervene, and liquid effusion follows.

Whenever air or gas gains access within the pleural cavity, by other modes, the accumulation of liquid either precedes or speedily ensues, and the coexistence of air or gas and liquid, let the character of the latter be what it may, gives rise to the affection called *pneumo-hydrothorax*. From what has been said, it follows that, although pneumothorax may exist as an affection distinct from pneumo-hydrothorax, the latter, in a clinical point of view, is chiefly important. In relation to diagnosis, it will suffice to consider both affections under the head of pneumo-hydrothorax, making incidental mention of the circumstances which characterize the presence of air without liquid—in other words, pneumothorax. It is to be remarked that our knowledge of this, as of several pulmonary affections, is to be dated from the researches of the illustrious discoverer of auscultation.

Pneumo-hydrothorax is always either of traumatic origin, or an effect of some antecedent morbid condition. It is never a primitive affection. And with reference to its discrimination, it is important to bear in mind the various modes in which it originates. Moreover, circumstances pertaining to its different pathological connections, affect materially both the symptoms and signs, more especially the latter, by which the diagnosis is established.

In by far the larger proportion of cases it occurs as an accidental complication of pulmonary tuberculosis, being produced by perforation of the lung resulting from rupture of the pleura over a cavity or a collection of softened tubercle. The rupture generally takes place during an act of coughing. Pneumothorax, then, becomes suddenly developed, and is speedily followed by acute pleuritis, with liquid accumulation. The size of the perforation, the persistency of a fistulous opening, and the freedom of communication established between the pleural cavity and the bronchial tubes are circumstances having important bearings on the development of certain physical signs. Statistics show that this accident is much more liable to occur on the left than on the right side. The situation at which it is oftenest found to take place, may also be borne in mind with reference to physical exploration.

According to Walshe, it is on the postero-lateral surface between the third and sixth ribs.[1] Its occurrence in the progress of tuberculosis is extremely rare. Several instances, however, have fallen under my observation.

It is liable to occur in connection with circumscribed gangrene of the lung, the pleura giving way over the eschar, inducing, in like manner, perforation and pleuritis. This is a rare result of a rare form of disease. I have met with two instances.

Perforation of the lung takes place still more rarely in connection with pulmonary apoplexy, tuberculous affection of bronchial glands, opening into the bronchial tubes and pleura, abscess, cancer, and hydatids. And it may be produced by an ulcerative process, taking its point of departure from the pleura, and extending to the bronchial tubes, in cases of chronic pleuritis and empyema.

Perforation of the thoracic parietes may lead to the admission and accumulation of air within the pleural cavity. This takes place in certain cases of empyema. Abscesses situated in the walls of the chest may result in an external communication with the pleural cavity. Thus produced, cases of pneumo-hydrothorax are distinguished from those involving perforation of the lung, and communication with the bronchial tubes, by the absence of certain physical phenomena which involve the latter anatomical conditions in their production.

Penetrating wounds of the chest, on the one hand, and, on the other hand, injuries of the lung from the fractured extremities of ribs, or contusion, are the modes by which the affection is produced traumatically.

Instances have occurred of a fistulous communication between the alimentary canal (œsophagus and stomach) and the pleural sac, through which the gases from the former escape into the latter situation.

Finally, in some very rare instances, chemical decomposition of liquid contained in the pleural sac takes place sufficiently to occasion development of gas, without perforation either of the lung, thoracic parietes, stomach, or œsophagus. In such cases, the phenomena which involve the admission of air from the bronchial tubes into the pleural cavity are of course wanting.

In this category may be placed the transient production of gas, in some mode not easily accounted for, in connection with pneumonitis, of which an instance was reported by Dr. Graves, and another by the chest; sometimes limited to the summit, and occasionally diffused over the greater part of the affected side. It has been known to accompany the act of deglutition, as well as the acts of breathing, speaking, and coughing.

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[1] This is quoted as more correct than the statement made by some writers, that it is most liable to occur near the apex of the lung. The pleural adhesions so uniformly occurring at the summit render it less liable to occur in that situation.

Inspection and mensuration furnish signs of importance. The affected side is permanently expanded, and its movements are accordingly limited. Frequently the accumulation of air and liquid leads to great dilatation and complete immobility, even with forced breathing. The intercostal spaces are widened and pushed outward, sometimes beyond the level of the ribs; the diaphragm is depressed, the mediastinum displaced, and the heart dislocated, being transferred, in some instances, to the right of the sternum—in short, the same appearances are presented as in cases of chronic pleuritis or emphysema. The signs furnished by inspection and mensuration alone would not enable the observer to distinguish between pneumo-hydrothorax and chronic pleuritis or empyema. Percussion and auscultation, however, at once supply differential characters. In chronic pleuritis and empyema with dilatation, the affected side is flat on percussion, with absence of respiratory sound in the great majority of instances, except over a small space at the summit. The strongly marked tympanitic sonorousness, extending over more or less of the affected side, cavernous, or amphoric respiration, and metallic tinkling, are wanting.

Dilatation does not uniformly occur in pneumo-hydrothorax. Liquid and air or gas may exist in the pleural sac, compressing the lung, without manifest enlargement. Cases, however, in which morbid changes in size and motion are not available in the diagnosis are exceptional.

Palpation furnishes signs which belong alike to chronic pleuritis and empyema, viz., diminution or abolition of vocal fremitus and fluctuation.

Finally, it is in this affection that succussion is available as a method of exploration. When air and liquid are contained in the pleural cavity, moving the trunk of the person to and fro, with the ear applied to the chest, produces a splashing noise, resembling that caused by shaking a bottle partly filled with water. This "Hippocratic succussion-sound," as it is frequently called, from the fact that it arrested the attention of the ancient father of medicine, is almost pathognomonic of pneumo-hydrothorax. The conditions under which it is presented, exclusive of this affection, occur only in pulmonary tuberculosis; and in the latter disease their occurrence is extremely rare. A very large excavation, partially filled with liquid, combines the circumstances necessary for its production. In this connection, however, the associated signs and symptons, in conjunction with the history, are so distinctive of tuberculous disease, that the presence of the sign, should it happen to be discovered, can hardly prove a source of any perplexity as to the diagnosis. For a farther account of this sign, as incidental to the affection under consideration, the reader is referred to the chapter in Part I, which treats of succussion.[1]

Diagnosis.—The symptoms of pneumo-hydrothorax, taken in connection with collateral circumstances, frequently are quite significant. In a very large majority of cases, the affection occurs in the course of pulmonary tuberculosis, and results from perforation of the lung. This accident, generally taking place during an act of coughing, is signalized by sudden acute pain in the chest, speedily followed by great dyspnœa, hurried respiration, frequency of the pulse, prostration, lividity, perspiration, diminished or suppressed expectoration, occasionally loss of voice, and an expression of great anxiety. When a case of phthisis offers this group of symptoms, manifested abruptly, perforation should be strongly suspected. At first, and for a brief period, the affection may be simply pneumothorax, but as acute pleuritis is generally quickly developed, with more or less liquid effusion, the disease soon eventuates in pneumo-hydrothorax. If, however, the physician rely exclusively on the symptoms, he will be likely to fall into errors of diagnosis; for the development of simple pleuritis may give rise to a group of phenomena, not unlike that just mentioned, and perhaps accompanied by a feeling, on the part of the patient, that something has given way in the chest; so that, as remarked by Dr. Stokes, the thorax is sometimes explored with a strong expectation of finding the evidence of perforation, when the result is negative. And, on the other hand, perforation is not always attended, in a marked degree, by the symptoms which have been enumerated. In some instances it is not immediately followed by notable disturbance, either of the respiratory function or of the system at large. In these cases, either the perforation is so small that the air and morbid products escape slowly into the pleural sac, inflammation becoming gradually developed; or extensive pleuritic

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[1] Vide chap. vii, page 330.

The tympanitic sonorousness which is found in a certain proportion of cases of simple pleuritis over the compressed lung, above the level of the liquid, is never so strongly marked as in most cases of pneumo-hydrothorax. If the quantity of liquid be moderate, the sound is not purely tympanitic, but vesiculo-tympanitic. The relative situations of sonorousness and flatness are not altered to the same extent by changes of posture. The walls of the chest are not so elastic. However, auscultation shows, in the one case, the lung to be in contact with, and in the other case to be removed from, the walls of the chest above the liquid.

The same remarks are applicable to the tympanitic resonance sometimes observed over lung solidified by inflammatory exudation. In the latter case, the bronchial respiration and bronchophony will be discovered by auscultation to be associated with the tympanitic sonorousness, and this combination, as will be seen presently, is proof not less against pneumo-hydrothorax than for the existence of pulmonary solidification.

The exaggerated resonance in emphysema is not purely tympanitic, but vesiculo-tympanitic, and in this affection the evidence of liquid in the chest is wanting.

On auscultation, the respiratory sound, as a rule, is feeble, distant, and frequently suppressed over the space occupied by the gaseous accumulation, except a free communication exists between the pleural cavity and the bronchial tubes. When the latter condition obtains, the cavernous and amphoric respiration may be discovered. It is in cases of pneumo-hydrothorax especially, that the amphoric modification of the cavernous respiration is most marked. These respiratory sounds are not constantly present, even when the anatomical condition just mentioned, which is necessary for their production, exists. The perforation may at times be situated below the level of the liquid or the orifice, or the tubes leading thereto, are liable to become obstructed; either of these circumstances will prevent their development. The opening into the pleural cavity may be too small for their production. Other things being equal, their intensity will be proportionate to the size of the fistula, and the calibre of the bronchial tubes to which it leads. Skoda, explaining these signs by the theory of consonance, contends that communication is not necessary; a thin stratum of tissue not preventing the production of the sounds. He is peculiar in entertaining the belief that the communication very rarely becomes persistent, the opening almost invariably being closed, partly by the compression of the lung, and partly by the effusion.

The cavernous and amphoric sounds when present are not diffused equally over all the space occupied by air, but are either limited to a circumscribed area, or heard at a certain point with an intensity which gradually diminishes as the ear is removed from it. Their maximum of intensity is, of course, over the site of the perforation; and they are therefore to be sought for in cases of tuberculosis where rupture is most apt to occur, viz., postero-laterally, between the third and sixth ribs.

The respiratory sound is suppressed over the space occupied by liquid effusion. This space will extend from the base of the chest upward to a distance proportionate to the quantity of liquid. At the summit, especially behind, the bronchial respiration may be discovered over the lung, which is not only condensed by pressure, but in addition, generally solidified by tuberculous deposit. It is, however, rarely, if ever, loudly developed. According to Stokes, the existence of tuberculous cavities in the compressed lung may sometimes be ascertained by their physical signs. On the healthy side, the respiratory sound is exaggerated.

The *vocal* phenomena vary not only in different cases, but in different parts of the chest in the same case. Absent below the level of the liquid effusion, the resonance may be wanting, feeble, or more or less marked, over the space occupied by air or gas, with an amphoric intonation, under the circumstances which give rise to amphoric respiration. At the summit, over the compressed lung, we may expect to find, more or less frequently, marked resonance; perhaps bronchophony, and possibly pectoriloquy.

An adventitious sound incident to the respiration, voice, and cough, is almost pathognomonic of pneumo-hydrothorax. This is metallic tinkling. It is a pretty constant sign, at least in cases involving perforation of lung. Exclusive of this affection, it is never met with, except, very rarely, in large tuberculous excavations. A sound somewhat analogous is sometimes produced within the stomach. The latter is occasional, and is readily distinguished by the fact that it occurs irrespective of the respiration, voice, or cough. For an account of the characters belonging to this sign and the circumstances (so far as known) connected with its production, the reader is referred to Part I.[1] It is found generally over the middle third of the chest; sometimes limited to the summit, and occasionally diffused over the greater part of the affected side. It has been known to accompany the act of deglutition, as well as the acts of breathing, speaking, and coughing.

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[1] Vide page 282, et seq.

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[1] Vide chap. vii, page 330.

Occurring from perforation of the lung, in phthisis, gangrene, empyema, or other pulmonary affections which have been mentioned, as well as from traumatic causes; from perforation of the chest by ulceration, abscess, or wounds; from ulcerative communication with the stomach or œsophagus, and from chemical decomposition of liquid in the pleural cavity, the signs are so distinctive and readily ascertained, that a positive diagnosis is rarely attended with any real difficulty, assuming the practitioner to be acquainted with the characteristics derived from the combined physical phenomena. The more important of the points involved in the discrimination from other affections have been noticed already, incidentally, in treating of the physical signs which belong to the affection. It seems, therefore, unnecessary to make the differential diagnosis the subject of formal consideration.

SUMMARY OF THE PHYSICAL SIGNS BELONGING TO PNEUMO-HYDROTHORAX.

Tympanitic sonorousness, usually intense, at the upper part of the chest, except in some instances, in which the ascent of air or gas is prevented by pleuritic adhesions; the tympanitic sonorousness extending for a greater or less distance downward, and if the accumulation be sufficient to produce lateral displacement of the mediastinum, being sometimes apparent beyond the sternum on the opposite side. The percussion-sound sometimes presenting a metallic ringing tone. Flatness at the base of the chest extending upward in proportion to the quantity of liquid effusion. Marked elasticity of the thoracic parietes accompanying the tympanitic resonance, and an abnormal sense of resistance below the level of the liquid. Change of level of the liquid with different positions of the trunk.

The respiratory sound feeble, distant, and often suppressed, if free communication between the cavity of the pleura and the bronchial tubes, does not exist. With such a communication, the cavernous and amphoric respiration frequently discovered. Possibly, in some instances, these signs are produced when a perforation which has taken place becomes closed by a thin stratum of false membrane. The cavernous and amphoric respiration oftenest heard, or the intensity greatest, between the third and sixth ribs, on the postero-lateral surface of the chest. Suppression of respiratory sound below the line of flatness, denoting the level of the liquid. Bronchial respiration, bronchophony, and possibly cavernous respiration and pectoriloquy, over the compressed lung at the summit of the chest. Exaggerated or supplementary respiration on the healthy side. Vocal resonance, over the space yielding tympanitic sonorousness on percussion, either wanting, or feeble, with an amphoric intonation in some cases in which the respiration is amphoric. Over the space yielding a flat percussion-sound, absence of vocal resonance.

Metallic tinkling frequently discovered, especially when the affection coexists with perforation of lung, and if produced within the pleura, pathognomonic.

Enlargement of the affected side, and diminished motion. Frequently great dilatation, involving effacement of intercostal depression or bulging, depression of diaphragm, displacement of mediastinum, and dislocation of the heart, and, under these circumstances, almost complete immobility even with forced breathing.

Diminution or abolition of vocal fremitus, and in some cases fluctuation, ascertained by palpation.

Hippocratic succussion-sound, or splashing.

PLEURALGIA.

Under this head I shall refer not alone to neuralgia affecting the intercostal nerves, to which, perhaps, the term *pleuralgia*, in a rigorous sense, should be restricted, but to an affection resembling rheumatism of the muscular or fibrous structures of the thoracic parietes, to which the term *pleurodynia* is usually applied. A *truly* rheumatic affection is comparatively rare. I shall also allude to the neuralgic affection called *angina pectoris*. Without contending for the nosological propriety of this arrangement, it is adopted for the sake of convenience, the diagnostic points by which these are discriminated from other affections applying to all of them alike, so far as concerns physical exploration. The characters distinguishing them from each other will be noticed incidentally.

The local symptoms characterizing intercostal neuralgia and pleurodynia are, in some respects, very analogous to those which belong to acute pleuritis. The differential diagnosis from other affections relates almost exclusively to their discrimination from the latter disease. And it will suffice to point out the distinctive characters involved in this discrimination.

Pain is the prominent feature in both the neuralgic and rheumatic affection. In its character and situation, the pain may simulate closely that which is due to acute inflammation of the pleura. Varying in degree in different cases, it may be considerable or intense, even exceeding the pain usually experienced in acute pleuritis. It is frequently lancinating in character, and may be felt especially in inspiration. Acts of coughing or sneezing occasion sometimes excruciating suffering. It is generally referred to the lower portion of the chest, in front and laterally,—the seat of pain in many cases of acute pleuritis. It is accompanied by tenderness on percussion or pressure. Guided solely by the rational or vital phenomena, it is sufficiently easy to confound intercostal neuralgia or pleurodynia with acute pleuritis; and this error, in fact, is not infrequently committed. Moreover, in both affections, the physical phenomena which belong to the first stage of acute pleuritis may be equally present. The movements of the affected side are restrained; a disparity in this respect, and even a slight difference in width, may be apparent. The respiratory murmur is feeble and interrupted. Percussion may possibly elicit, comparatively, slight dulness. How, then, is the discrimination to be made? It involves attention both to symptoms and signs, together with the circumstances under which the affection is presented; and, with proper care and knowledge, a positive diagnosis cannot always be at once established.

Intercostal neuralgia, except as an occasional coincidence, is unattended by febrile movement, which is wanting also in the great majority of the cases of pleurodynia. On the other hand, acute inflammation of the pleura gives rise to well-marked and more or less intense symptomatic fever. This is an important point of distinction. The absence of febrile movement is evidence against acute pleuritis, if we observe the disease at its commencement, or shortly after the attack. But the presence of febrile movement is not to the same extent evidence against intercostal neuralgia and pleurodynia, because it may accidentally coexist with these affections.

The extreme severity of the pain, and the exquisite sensitiveness of the side to the touch, in some cases, militate strongly against the idea of acute inflammation, provided symptomatic fever be absent. In neuralgia affecting the walls of the chest, the tenderness is more superficially situated; the contact of the hand or slight pressure is not so well borne as in cases of acute inflammation, while firm steady pressure made with the open palm occasions a disproportionally less amount of suffering. Movements of the trunk and upper extremities produce distress in a severe attack of neuralgia frequently greater than in acute pleuritis, the respiratory movements being more especially the cause of pain in the latter. The pain at the same time in neuralgia is more independent of respiration and the motions of the body. It is less uniform, marked remissions and sometimes distinct intermissions occasionally occurring. When this is the case it is quite distinctive. It may be sometimes promptly and effectually relieved by a full opiate; while the pain from acute inflammation may in this way be perhaps mitigated but not controlled. Cough is a more constant and prominent symptom in acute pleuritis. It is often wanting in intercostal neuralgia and pleurodynia.

Both neuralgia and rheumatism, when seated in the thoracic walls, may be associated with similar affections manifested at the same time in other parts of the body. This is ground for a presumption as to the character of the chest-affection. In herpes zoster the acute pains in the chest may be presumed to be neuralgic, because severe thoracic pains are well known to accompany this affection without involving inflammation. The pathological association thus in this case becomes diagnostic.

MM. Bassereau and Valleix have called attention to characteristics of intercostal neuralgia which are important in a diagnostic point of view,[1] and which serve to distinguish this affection from pleurodynia.

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[1] Valleix, op. cit.

On careful examination of the chest by palpation, the soreness is found to be not diffused, but confined to certain isolated points. These points, according to the observers just named, are pretty uniformly three in number, viz., 1st, By the side of one or more of the dorsal vertebræ; 2d, over one or more, usually two or three, of the intercostal spaces generally of the sixth, seventh, and eighth ribs, about midway between their two extremities; and 3d, over the costal cartilages or in the epigastric region. The tenderness in these three situations is often extremely circumscribed. The points correspond to branches of the dorsal nerves which have a superficial distribution.[1] Pressure on the first point, viz., by the side of the vertebral spines, is most constantly and in the most marked degree productive of pain. The frequent coexistence of this, as of other neuralgic affections, with tenderness on pressure over certain of the vertebræ, is a fact with which practitioners are familiar in this country, where the phenomena incident to what is usually called *spinal irritation* are probably more common than in France. When, as is not unusual, pressure over a tender portion of the spinal column provokes a paroxysm of pain in the affected part, and especially if the nerves distributed to the latter are connected with the medulla spinalis at the portion corresponding to the seat of tenderness, the neuralgic character of the affection is altogether probable.

Shifting of the locality of the pain is another diagnostic trait. This is apt to occur in neuralgic and rheumatic affections, while in pleuritis, the pain is more fixed in the same situation. In some cases of pleuralgia, the pain is seated in both sides. This is significant of its neuralgic or rheumatic character.[2]

But a positive diagnosis rests on the absence of the physical signs denoting the presence of inflammatory products within the pleural sac. A well-marked intra-thoracic friction-sound is conclusive as to the existence of pleuritis; but its absence is not negative proof of a neuralgic or rheumatic affection, for this sign is not uniformly, and, indeed, but rarely, discovered in the early stage of pleuritic inflammation. Acute pleuritis, however, is accompanied by more or less liquid effusion, giving rise to a series of physical phenomena which have been described. If these phenomena are not developed after a certain time from the date of an attack of acute pleuritic pain, the diagnosis of a neuralgic or a rheumatic affection is settled, reasoning by way of exclusion. In cases, therefore, in which the symptoms and associated circumstances leave room for doubt, it is prudent to defer an absolute conclusion for two or three days, when, from the absence of the evidence of effusion, the non-existence of acute pleuritis is almost certain. The difficulty thus attending the discrimination of intercostal neuralgia and pleurodynia from acute pleuritis, pertains chiefly to the dry or plastic stage of the latter affection. So soon as it may be decided that, assuming acute inflammation to exist, effusion should have taken place, the differential diagnosis ceases to be an intricate or doubtful problem. This result, it is to be borne in mind, usually follows speedily the access of inflammation; and it is certainly extremely rare, that an amount of effusion easily detected fails to occur within the first three or four days. In the majority of instances, probably, this is the case as early as the second day.

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[1] Grisolle, Pathologie Interne t. ii, p. 584.

[2] A neuralgic affection seated in both sides is significant of some lesion of the spinal cord.

A fact stated in connection with the subject of acute pleuritis may be here repeated. This disease is occasionally preceded by neuralgic pain in the chest, more or less severe and persisting, for several days before the symptoms denote an inflammatory attack. Two cases, illustrating this fact in a striking manner, already referred to, have fallen under my observation.

It is stated by some writers that liquid effusion, and all the phenomena denoting acute pleuritis, may result from a rheumatic affection within the chest. This, in effect, is saying that acute inflammation of the pleura may be developed in connection with the morbid condition of the system in which consists the essential pathology of rheumatism. In other words, such cases, clinically, are neither more nor less than cases of acute pleuritis. To cases of this kind I have not, of course, had reference in the foregoing remarks.[1]

The occasional development of pleuritis during the course of acute rheumatism, is a fact to be borne in mind. The occurrence, under these circumstances, of the symptoms of pleurodynia, is by no means proof of the non-existence of veritable inflammation. Careful and repeated explorations of the chest are to be made, and equally in cases in which circumstances point to intercostal neuralgia, in order to determine as regards the presence or absence of the physical signs of pleuritis. In view of the liability to pleuritis in the progress of rheumatism, without the information to be obtained by physical exploration, the existence of inflammation, as well as simple pleurodynia, might be incorrectly inferred. It is hardly necessary to refer to the possibility of attributing to pleuritic inflammation the pain sometimes incident to an affection of the heart, occurring in rheumatism. This would more properly have been noticed under the head of Pleuritis. The positive signs referable to the heart, and the absence of the signs of inflammation of the pleura, suffice to obviate error with respect to this point.

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[1] Were discussions respecting the seat and nature of diseases embraced within the scope of this work, the question would arise, whether pleurodynia is not, in the sense in which it is practically regarded, oftener a neuralgic than a rheumatic affection, or both affections combined.

A subacute but persisting neuralgic affection is very frequently met with in females, the pain referred to the lower part of the chest on one or both sides. It is not severe, but of indefinite duration. It occurs especially in anæmic or chlorotic persons, associated frequently with disorder of the menstrual function, and generally with tenderness over the spinal vertebræ. The circumstances just mentioned embrace certain positive characters by which it may be distinguished; but the absence of the physical signs of intra-thoracic disease confirms its neuropathic character.

The symptomatic phenomena of angina pectoris are so peculiar and distinctive that, as regards the possibility of confounding it with any other affection referable to the chest, it claims but a passing notice. Its paroxysmal recurrence; the pain shooting in various directions, and especially into the left upper extremity; the difficulty of respiration, palpitations, great anxiety, and sense of impending dissolution, together with the physical signs of an organic affection of the heart, characterize this affection, so as to render the diagnosis sufficiently easy.

Diaphragmatic Hernia.

In consequence of the congenital absence of a portion of the diaphragm, perforation by rupture and wounds, or a yielding of this septum at certain points, and sometimes over its whole extent on one side, the stomach, intestines, and other of the abdominal viscera, may either be contained within or encroach more or less on the thoracic space. This transposition of organs gives rise to certain phenomena, discovered by a physical examination of the chest. Diaphragmatic hernia—a term which, with strict propriety, is applied only to protrusion through the diaphragm of parts situated below it—is extremely rare, but the physician is liable at any moment to meet with an instance, although I believe no one has ever reported more than a single case. The very infrequency of the affection renders it peculiarly interesting to the diagnostician; and it is desirable for him to be prepared to recognize it, should an instance happen to fall under observation.

An affection so rare that it can hardly be expected ever to occur more than once within the experience of a lifetime, must, of course, be studied by means of cases contributed by numerous observers. For this reason it has heretofore received but little attention. A distinguished American physician, Dr. Bowditch, of Boston, has recently, in connection with the report of an interesting case observed by himself, gathered nearly if not quite all the cases contained in the annals of medical literature (88 in number), and subjected them to an elaborate numerical analysis.[1] The present brief consideration of the subject will be based on the results contained in this valuable paper.

The different varieties of diaphragmatic hernia may be classified as follows: 1. When parts of the abdominal viscera are forced through some one of the natural openings of the diaphragm, viz., that of the aorta, vena cava inferior, an intercostal nerve, or the œsophagus. 2. When portions of the diaphragm are wanting. This results from an arrest of development, and is, of course, congenital. 3. Hernia from accidental wounds or lacerations. 4. When one side of the diaphragm is violently forced up into the chest, so that the lung is compressed, and all the signs of the affection, as seen in the other classes, are observed. This, strictly speaking, is not hernia, but from the similarity as respects the physical conditions and phenomena, it may be included in the same category. In their relative frequency of occurrence the four classes rank in the following order: (a) hernia from accidents, constituting more than one-half of the number of cases; (b) from malconstruction, about one-third; (c) from dilatation of natural openings, about one-twelfth; (d) from diaphragm being pushed up, about one in thirty cases.

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[1] "Peculiar Case of Diaphragmatic Hernia, in which nearly the whole of the left side of the diaphragm was wanting; so that the stomach and a great part of the intestines lay in the left pleural cavity; compressing the left lung, and forcing the heart to the right side of the sternum. This condition, evidently congenital, existed in a man who died at the Massachusetts General Hospital, with fracture of the spine, caused by a heavy blow upon it; to which is added an analysis of most, if not all, of the cases of diaphragmatic hernia found recorded in the annals of medical science. By Henry J. Bowditch, Member of the Boston Society for Medical Observation. Presented to the Society in 1847." Published in the Buffalo Medical Journal, June and July, 1853; and issued by the author in a separate publication.

The affection occurs much oftener on the left than on the right side (41 out of 59 cases); a disparity for which anatomical reasons may be offered. It is evident that the abdominal parts contained within the chest will be covered by the pleura and peritoneum in some, and not in other cases. When thus invested, the hernia is said to be sacculated. Sacculated hernias are vastly more frequent on the right than on the left side (3 only out of 11 cases of hernia on left side were sacculated, and 11 of 18 cases on the right side). The weakness of the diaphragm on the right side at a point just to the right of the ensiform cartilage, affords an explanation of this fact. The particular parts of the abdominal viscera which are contained within the chest, and the extent of the malposition, will, of course, depend on the situation and size of the opening. The solid organs, viz., the liver and spleen, as well as the hollow viscera, are liable to hernial protrusion.

Strangulation at the orifice is liable to occur. The parts may present, or not, in cases examined after death, evidences of inflammation, recent or more or less remote, affecting either the pulmonary or abdominal organs, or both. In several instances all these parts presented a healthy appearance. The coexistence of tubercles is rare. The lungs are of necessity compressed in proportion as the thoracic space is occupied by the abdominal viscera. Frequently the compressed lung, exclusive of condensation, is found to be healthy, and is readily inflated. Solidification from pneumonitis has been observed. The heart is frequently displaced, generally to the right. Pleuritic effusion exists in a certain proportion of cases.

Physical Signs.—The cases on record of diaphragmatic hernia afford few data for determining, by means of numerical analysis, the physical phenomena which belong to the affection. Many of the cases were observed prior to the discovery of auscultation, and in most of those reported since that era, exploration of the chest during life was either performed imperfectly or altogether neglected. Laennec never met with an instance of the affection, but it did not escape his attention, and he suggested that it might be recognized by absence of the respiratory murmur, and the presence of borborygmi in the chest. In the case observed by Dr. Bowditch, the signs were carefully noted, and in a few of the cases analyzed by him more or less of the physical phenomena were ascertained. Upon these facts, together with the inferences which may be rationally predicated on the anatomical conditions, must rest, with our existing knowledge, an account of the physical signs.

Of the cases analyzed by Dr. Bowditch, in five percussion was resorted to. Of these five cases dulness over the back on the affected side existed in four. But in three of four cases there was either pneumonitis or pleuritic effusion; and in the fourth case the liver, colon, and omentum were embraced in a sacculated protrusion. In Dr. Bowditch's case percussion elicited a highly marked tympanitic sonorousness. It is evident, that in proportion to the amount of the hollow viscera contained within the chest will be the degree and the extent of the tympanitic resonance. And this resonance, both in degree and extent, will be likely to present at different times fluctuations dependent on the varying quantity of the stomach or intestines within the chest, and the greater or less distension of these parts from gas. The presence of the solid organs, the liver and spleen, must give rise to dulness. Liquid effusion will lead to the same result. In any case, at the upper and posterior part of the chest, over the compressed lung, the percussion-sound will be likely to be dull; and the more, if the lung be solidified by inflammatory exudation.

A satisfactory account of the auscultatory phenomena, with a single exception, appears not to be contained in any of the cases, save the one observed by Dr. Bowditch. In these two cases the respiratory murmur over the greater part of the affected side was wanting, and on the opposite side it was exaggerated. In Dr. Bowditch's case the respiratory murmur was heard perfectly vesicular and pure above the second rib.

Aside from these cases, in three a sub-crepitant rale was noticed; but in all the existence of pneumonitis was found at the autopsy.

The most significant of the signs, as anticipated by Laennec, are the peculiar gastric or intestinal sounds diffused more or less over the affected side. Dr. Bowditch describes these sounds as gurgling, whistling, and blowing, and although excited at times by the act of respiration, they were heard when the patient held his breath. Metallic tinkling was occasionally observed; such as is sometimes heard over the stomach. Dr. Bowditch suggests that auscultatory phenomena may probably be produced by pressing suddenly on the abdomen, and thus forcing air into the intestines while in the pleural sac.

If the heart be displaced, the cardiac sounds will, of course, be transferred to an abnormal situation.

In three of five cases in which the chest was examined by inspection, there was more or less enlargement of the affected side. That this is generally incident to the affection may reasonably be inferred, from the large proportion of instances in which the accumulation of abdominal viscera within the chest is sufficient to induce great compression of the lung. In fifty-five of eighty-eight cases the lungs were found to be *much* compressed. Diminished motion or immobility of the affected side must necessarily accompany its dilatation. These signs will be likely to vary from time to time, in accordance with varying conditions as respects the amount of hernial protrusion and of gaseous distension of the protruded viscera. Liquid effusion in some cases must concur in producing dilatation and diminishing the mobility of the affected side. It is superfluous to add, that in determining these changes, mensuration, as well as inspection, may be employed.

By means of palpation the abnormal position of the heart may be ascertained. It is probable that the vocal fremitus will be diminished or abolished on the affected side; but observation has not been directed to this point.

Diagnosis.—The symptomatic phenomena which are in any manner distinctive of the affection, relate to the respiration. The analysis by Dr. Bowditch shows that at least three-fourths of cases of the different varieties of diaphragmatic hernia are characterized by more or less embarrassment of respiration, consisting of oppression, increased frequency, dyspnœa, and in one case orthopnœa. Posture has been observed to exert a marked influence on the symptoms referable to the respiration. In some instances the difficulty of breathing was greatly increased in the recumbent posture, which is explained by the tendency, from gravitation, to a greater protrusion either of the viscera or their contents within the chest. Irrespective of position, the fluctuating conditions as regards the quantity of hollow viscera protruding through the diaphragm, and their distension with gas, will account for the difficulty of breathing occurring paroxysmally, or being much greater at some times than at others—a fact repeatedly observed. But embarrassment of the respiration is not always a prominent symptom, even when one side of the chest is nearly filled with abdominal viscera. This is shown by the case reported by Dr. Bowditch. In this case, the patient, aged 17, was able to perform the duties of a laborer, and died, not from this affection, but from fracture of the spine produced by a blow from a heavy piece of timber. Moreover, the characters belonging to the embarrassment of respiration, when present, do not possess much significance.

Judged by past experience the diagnosis would appear to be extremely difficult, for of all the cases collected by Dr. Bowditch the nature of the affection had been determined before death in but a single instance. This instance came under the observation of Mr. Lawrence, of London. In the case observed by Dr. Bowditch the diagnosis was made. This difficulty is, however, more apparent than real. From its great infrequency the affection is not suspected or even thought of; and the physical signs have been but little studied, and are yet to be fully settled by observation. Upon the latter it is sufficiently clear the diagnosis depends: the existence of the affection can never be positively ascertained by the symptoms alone. With the symptoms and signs combined, Dr. Bowditch is probably correct in saying that "the diagnosis of diaphragmatic hernia is as easy as that of almost any other chronic, and possibly acute disease."

Dyspnœa, either constant or produced by exertion, and more especially when it comes on suddenly and as suddenly goes off, should suggest the idea of diaphragmatic hernia, provided it be not explicable by the existence of some other affection the nature of which is positively ascertained. If the affection be congenital, in most cases more or less embarrassment of respiration will be found to have existed from birth. If due to a rupture or wound, the difficulty will date from some accident, which may assist in the diagnosis. In connection with embarrassed respiration to a greater or less extent, the following signs, in combination, constitute the physical characters by which the affection is to be recognized. Tympanitic percussion-resonance; absence of respiratory murmur; the presence of sounds identical with those observed over the stomach and intestines, viz., borborygmi and metallic tinkling, both taking place when breathing is suspended; dilatation of the affected side in the majority of instances, with deficient motion or immobility, and probably absence of vocal fremitus.

Assuming this group of signs to be present, diaphragmatic hernia can be confounded only with emphysema and pneumo-hydrothorax. The differential diagnosis from these two affections involves points which are sufficiently distinctive. Emphysema is generally accompanied by paroxysms of asthma, the symptomatic characters of which will serve to distinguish it. It is accompanied by more or less cough and expectoration, these symptoms being only occasionally present in diaphragmatic hernia. But physical exploration in emphysema shows a sonorousness not purely tympanitic, but vesiculo-tympanitic; dilatation and deficient motion especially marked at the upper part of the chest in the majority of instances; bronchial rales or a modified respiratory sound generally more or less diffused, together with the absence of borborygmi and metallic tinkling.

Pneumo-hydrothorax in nine cases out of ten is suddenly developed as the result of perforation of the lung in the course of phthisis, the existence of which has been established. Or it occurs from perforation taking its point of departure from within the pleura, in the course of chronic pleuritis, the latter affection having been previously ascertained to exist, if the case have been under observation. It is only in cases in which these antecedents cannot be ascertained, that diaphragmatic hernia is to be suspected. As respects physical signs, the two affections are in several respects similar. Tympanitic resonance, absence of respiratory murmur, dilatation and deficient mobility, abolition of fremitus, and displacement of the heart, are common to both. But each affection has its positive signs. In the majority of cases of pneumo-hydrothorax metallic tinkling occurs in connection with the respiration, voice, and cough; and in many instances the cavernous and amphoric respiration and voice are present. The succussion-sound may be pretty uniformly produced. Absence of fluctuation is often discovered. In diaphragmatic hernia borborygmi constitute a positive and strikingly peculiar sign; and tinkling or amphoric signs are found to occur, not in synchronism with acts of breathing, speaking, or coughing, and irrespective of the movements of the body. The discrimination must be based on the presence of the latter phenomena, and the absence of the signs and the circumstances relating to the previous history, which characterize pneumo-hydrothorax.

Farther clinical observation of diaphragmatic hernia, especially as respects the results of physical exploration, may lead to the knowledge of new diagnostic points, which cannot now be foreseen. At a future period some one, imitating the zeal and industry of Dr. Bowditch, will be able to gather together and analyze an extended series of cases, in which the signs, as well as symptoms, have been carefully observed and noted; but in the meantime it is important that the affection be recognized, not merely for the gratification afforded by skill in the diagnosis of rare and curious forms of disease, but because much may be done by judicious management to contribute to the comfort and safety of the patient.

CHAPTER VIII.

DISEASES AFFECTING THE TRACHEA AND LARYNX—FOREIGN BODIES IN THE AIR-PASSAGES.

In its application to the diagnosis of tracheal and laryngeal affections, physical exploration is far less important than when the lungs are the seat of disease. The symptomatic phenomena belonging to pulmonary affections are never to be dissociated, clinically, from the physical signs, but, relatively, the latter are in general much more distinctive and reliable. It is otherwise in diseases affecting the air-passages above the bifurcation of the trachea. Here the symptoms are mainly to be relied on, the results of physical examination holding a comparatively subordinate rank. This being the case, I shall not, as hitherto, consider the different affections included in this group under separate heads, but refer to them, individually, in an incidental manner, in treating of the general application of the principles and practice of physical exploration to diseases affecting the trachea and larynx. Another reason for pursuing this course is, the same physical signs will be found to be common to different affections, and the general principles regulating the practice of exploration are in a great measure applicable alike to all.

Of the different methods of examination, auscultation is alone adapted to the investigation of morbid conditions seated in the trachea or larynx. Dr. Stokes has suggested that percussion may in some instances furnish results worthy of attention.[1] He does not, however, present any facts illustrative of its value in this application. The inventor of mediate percussion, and the ardent advocate of its capabilities, Piorry, assigns to it a very limited scope of availability in these affections. He claims in behalf of this method, that it may sometimes be useful in determining the precise line of direction of the trachea and larynx, when they are buried beneath or imbedded in a large tumor on the neck. The percussion-sound may also afford some aid in estimating the distance of the tube from the surface.

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[1] Diseases of the Chest, etc.

An amphoric resonance, attributed by Piorry to the presence of air and liquid, he thinks denotes the presence of secretions in this situation; but this view of the significance of the sound is, as already stated, more than questionable. Finally, in a case of subcutaneous emphysema, in which very marked resonance exists over the neck, there is ground for the suspicion that rupture of the larynx has taken place, giving exit to air into the surrounding areolar tissue.[1]

The discoverer of auscultation attached very little importance to the application of this method to the diseases of the windpipe. Of those who since the time of Laennec have given special attention to physical exploration, few have deemed this branch of the subject deserving of consideration; and the sum of what is at present actually known, is probably embraced in the writings of Dr. Stokes,[2] and in two papers contributed by M. Barth, of Paris.[3] The materials for the few remarks which are to follow, will be chiefly obtained from the sources just referred to.

Physical exploration, in diseases affecting the trachea and larynx, admits of a *direct* and *indirect* application. By the term direct, I mean to refer solely to auscultation of the windpipe. The foregoing remarks have related to physical exploration as thus restricted. Indirectly, the physical exploration of the chest is applicable, in order to determine whether pulmonary disease coexists or not. The importance of physical signs is much greater in the latter than in the former application. Indeed, the examination of the chest in connection with diseases affecting the trachea and larynx is often of very great importance. We will consider first, direct exploration; in other words, the physical signs developed by auscultation of the trachea and larynx; and, second, indirect exploration, or the examination of the chest in the investigation of diseases seated in these parts.

1. *Auscultation of the Trachea and Larynx.*—The results obtained by auscultation in health have been considered in Part I.[4] Briefly, also, the adventitious sounds or rales produced in this situation, have been adverted to.[5] It remains to notice here the relations of pathological phenomena to the different forms of disease. The

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[1] Traité Pratique d'Auscultation, etc., par Barth & Roger, 1854, p. 704.

[2] On Diseases of the Chest.

[3] Archives Générales de Médecine, Juillet, 1838, et Juin, 1839; also, Traité Pratique d'Auscultation, etc. par Barth and Roger, 1854, p. 255.

[4] Vide page 137.

[5] Vide page 217.

anatomical conditions, giving rise to auscultatory signs, are the following. 1. Diminution of the calibre of the tube, either at certain points, or, in some instances, over its whole extent. This occurs in connection with various affections, viz., swelling of the lining membrane and submucous infiltration in laryngitis; œdema of the areolar tissue above the vocal chords (œdema glottidis); spasm of the glottis and laryngismus stridulus (false croup); the exudation of lymph on the mucous surface (true croup); accumulation of viscid adhesive mucus; tumefaction of the margins of ulceration; vegetations or morbid growths, and the pressure of an aneurismal or other tumor. 2. Loss of substance by ulceration from tuberculous or syphilitic disease. 3. Membranous deposit becoming loose and partially detached, and a pedunculated polypus admitting of change of position. 4. Accumulation of liquid, mucous, purulent, serous, or bloody. The presence of foreign bodies will be noticed under a distinct head.

Contraction of the space within the tube from the several causes just enumerated, may give rise to abnormal modifications of the respiratory sound, consisting of augmented intensity, roughness of quality, and marked elevation of pitch, or adventitious vibratory sounds (dry rales) may be developed. The latter may be on a high or low key, and they frequently have a musical intonation. They represent, on an exaggerated scale, the bronchial sibilant, and sonorous rales. They are often sufficiently loud to be heard at a distance, constituting stridor or stridulous breathing, but when not thus apparent they may be discovered with the stethoscope applied over the larynx or trachea.

Do these diversities of modified and adventitious respiratory sounds possess, respectively, special diagnostic significance? Observation, as yet, has furnished but little ground for an affirmative answer to this question. They appear to belong alike to the different forms of disease, inducing the same anatomical condition, viz., diminution of the calibre of the tube. Barth has observed, in some cases of laryngeal ulcerations with tumefied borders, involving obstruction, a peculiarly loud sonorous rale (*cri sonore*) in inspiration, giving the impression of the rapid passage of air through a narrow orifice, which he regards as distinctive of the morbid condition just mentioned. It is, however, difficult to obtain from his description, a very clear idea of the special character of sound to which he refers. The same observer thinks that a sonorous rale, presenting a strongly marked metallic quality, like a sound produced within a tube of brass, is heard oftener in croup than in other affections which diminish the calibre of the windpipe. Stokes describes a rale produced within the larynx resembling the rapid action of a small valve, combined with a low humming sound,[1] which he regards as peculiar and quite characteristic of chronic laryngitis with ulceration. He states that this rale may exist on one side of the larynx without being perceptible on the other, its situation perhaps corresponding to a circumscribed ulceration. With reference to this sign, the same remark is applicable as to the loud sonorous rale (*cri sonore*) above mentioned. In both instances, the data are insufficient to establish a pathological significance. It is not improbable that farther clinical study may lead to distinctive characters pertaining to particular sounds. As already intimated, I have nothing to contribute to this branch of the subject from my own observation.

The situation of the auscultatory signs which have been mentioned may furnish information as to the seat of the disease and its extent. They may be limited to a small space. If they are persistingly heard in the same spot, there is reason to suppose that the local affection is thus circumscribed. This may possibly be found to be useful, with reference to the feasibility of making topical applications, and may serve as a guide in the direction of the instrument used for that purpose to the proper place. If the abnormal sounds be not thus localized, they may be found to present at some point, distinctly, a maximum of intensity. This may equally indicate either the seat of the disease, or the point at which it is greatest in amount. To serve as a guide to the locality of disease, the abnormal sounds must be repeatedly or constantly found to be circumscribed, or to have their maximum of intensity well defined and in the same situation, for in certain instances the sounds are due to transient physical conditions, viz., spasm, or the accumulation of viscid mucus. The laryngo-tracheal sounds are sometimes so intense and diffused as to be transmitted over the chest, obscuring the pulmonary sounds and liable to be mistaken for the latter. This source of error has been already referred to.

A tremulous, flapping sound (*tremblotement*) has been observed by Barth in cases of croup, at a period of the disease when it was supposed to indicate a loosened and partially detached condition of the false membrane. He regards this sign as affording valuable information in cases of croup, denoting, in the first place, progress in the processes by which the exudation is detached; and, in the second place, enabling the auscultator to judge respecting the extent over which the exudation is diffused. If the rale be limited to the larynx, it is a favorable sign, showing that the false membrane is probably confined to this part, and that the conditions are favorable for its speedy removal by expectoration; but if it extend over the trachea and especially to the bronchi, the prognosis is rendered unfavorable by this evidence of the extension of the disease.

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[1] Dr. C. J. B. Williams suggests that the humming sound may have been produced in the jugular vein. (On Diseases of the Respiratory Organs, American ed. 1845, p. 131.)

Theoretically, we may suppose that a pedunculated tumor within the larynx or trachea, moving to and fro in the respiratory acts, might occasion a sound of friction, which, taken in connection with the symptoms, should render probable the nature of the affection. In a case reported by M. Ehrmann, of Strasburg,[1] a valvular sound (*bruit de soupape*), was heard distinctly in a forced respiration.

Erosive ulcerations, which sometimes destroy, to a greater or less extent, the vocal chords, it may be presumed must give rise to modifications of the respiratory sound, more especially in expiration, by enlarging the space at the glottis. The contraction at this point, from the approximation of the chords in the expiratory act not taking place, one of the conditions upon which probably depend, in health, the intensity and elevation of pitch of the laryngo-tracheal sound in expiration, is wanting; and under these circumstances it may be anticipated that this sound will become relatively feeble and low in pitch. This is an interesting point to be settled by observation.

The foregoing remarks have had reference to abnormal modifications of the respiratory sounds together with dry or vibrating rales. Bubbling or gurgling sounds attest the presence of liquid in the trachea and larynx. Owing to the size of the tube, and the force of the column of air which traverses it in respiration, the presence of a considerable accumulation of mucus, or other liquid, is indicated by loud rales, heard at a distance, and commonly known as the tracheal rattle, or (since such an accumulation very rarely takes place except toward the fatal termination of disease), the "death rattle." These sounds are not distinctive of any affection of the windpipe; they denote deficient sensibility and loss of muscular power to such an extent, that either efforts are no longer made or they prove insufficient to expel the accumulated matter by expectoration. But moist râles may be discovered in some instances by stethoscopic examination when they are not apparent at a distance, and to some extent they

[1] Valleix, op. cit.

may be made available in diagnosis. Thus it is suggested by Piorry that in certain cases of hæmoptysis, a humid rale localized in the larynx, provided no rales are found at the lower part of the trachea and over the pulmonary organs, is evidence that the hemorrhage has taken place from within the larynx.[1] Again, Barth and Roger state that in cases of ulcerations in the larynx, a gurgling or bubbling sound found at a particular part of the organ, may point to the seat of these ulcerations, or the maximum of the intensity of the sounds may indicate the side on which the ulcerations are most numerous and extensive. These sounds are most likely to be produced, and to be available in localizing ulcerations, when the latter are situated at the bottom of the ventricles of the larynx.

In conclusion, auscultation in affections of the trachea and larynx furnishes certain physical phenomena, but, with our present knowledge, these phenomena embrace very few characters which are distinctive of particular forms of disease. They show the calibre of the tube to be diminished, but not the cause of the contraction, nor do they, in general, afford definite information as to the amount of obstruction. The latter point is determined, as will be seen presently, much better, indirectly, by an examination of the chest. They show the presence or absence of liquid; and in croup, information may sometimes be obtained which is of aid in forming an opinion as to the condition of the false membrane, and the distance to which it extends below the larynx. The seat of inflammation or ulceration may in some cases be ascertained, by finding that the morbid phenomena are persistingly fixed in a particular part, perhaps even confined to one side of the larynx; or, if more extended, by observing that at a certain point sounds have distinctly a maximum of intensity. These few words comprise the summary of what is actually known. The other points mentioned in the preceding remarks require to be confirmed by farther observation. It is by no means improbable that clinical investigations may hereafter develope facts, which will render the direct application of physical exploration to the diagnosis of diseases affecting the trachea and larynx of much greater importance than it is with our present knowledge of the subject.

2. *Examination of the chest in the investigation of diseases affecting the trachea and larynx.*—Examination of the chest in cases of laryngo-tracheal affections, as already remarked, is of much impor-

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[1] Barth and Roger, op. cit. p. 263.

tance. Grave errors of diagnosis may be thereby avoided. Lobular pneumonitis and capillary bronchitis are sometimes mistaken for croup, and treated with repeated emetics and topical applications to the larynx, when the phenomena revealed by thoracic exploration would show the existence of these affections. It is true that the existence of one or the other of these affections does not constitute conclusive proof that croup does not exist, for they are sometimes associated with the latter. Taken in connection, however, with other points, the greater importance of which will be admitted, they are to be taken into account as affording an adequate explanation of certain of the symptoms which might otherwise be referred to the larynx.

To determine whether pulmonary disease coexists, or not, with an affection of the trachea or larynx, is a grand object in examining the chest. In cases of the affection just cited, croup, it is very desirable to settle this point, with reference to the prognosis, to the treatment to be pursued, and especially when it becomes a question as to the propriety of resorting to tracheotomy. The advantages of this knowledge in these relations is sufficiently obvious.

In cases of chronic laryngitis, the question arises as to its coexistence with tuberculous disease of the lungs. Pathological observations have established the fact that in the vast majority of cases the laryngitis is a complication of an antecedent pulmonary tuberculosis, and that the laryngeal affection is, in fact, tuberculous. But this rule is not invariable. The affection may have a syphilitic origin. The law of probabilities will not then suffice for the diagnosis; and the symptoms are not alone adequate to settle the question, the more because the most prominent, viz., the cough and expectoration, may be attributed to the laryngitis. It is not uncommon for practitioners who do not avail themselves of physical exploration, in cases of phthisis complicated with laryngitis, to persuade themselves and their patients that the disease is seated exclusively within the larynx. It is by means of the precision given to the early diagnosis of pulmonary tuberculosis, that the consecutive occurrence of the laryngeal affection has been established, and that an extension of disease from the larynx to the lungs, as implied in the term *laryngeal phthisis*, very rarely, if ever takes place. A persisting chronic laryngitis, then, warrants a strong presumption of a deposit of tubercle in the lungs, but the proof positive is the evidence afforded by the presence of the physical signs revealed by an examination of the chest. On the other hand, the non-existence of tubercle is to be inferred from the negative results of physical exploration.

The syphilitic origin of a laryngeal affection may in some instances be inferred in connection with the results of an examination of the chest. This conclusion may be reasonably entertained, when the affection is found not to be associated with pulmonary tuberculosis, and the patient is known to have been affected with syphilis.

Another grand object to be attained by an examination of the chest in the various forms of disease affecting the trachea and larynx, is to determine the actual amount of obstruction to the passage of air. This important point can be settled vastly better by an exploration of the chest than by auscultation directly of the windpipe, and frequently more satisfactorily than by the symptoms. The evidence of the amount of obstruction is the degree of diminution or the suppression of the vesicular murmur. This diminution or suppression, when the obstruction is seated in the trachea or larynx, will, of course, be uniform on the two sides of the chest. In fact, the existence of some affection of the air passages above the tracheal bifurcation is to be suspected, even should the symptoms not point to disease in that direction, if the vesicular murmur is found to be equally diminished on both sides in a notable degree, or suppressed, provided the physical signs of emphysema of the lungs are wanting. The error of attributing the diminution or suppression of the vesicular murmur, due to an obstruction above the tracheal bifurcation, to emphysema, is to be guarded against by attention to the other signs, which serve by their presence or absence to establish or exclude that affection. Whatever may be the disease which diminishes the calibre of the windpipe, so long as the vesicular murmur continues to be tolerably developed, the patient is not in immediate danger from suffocation, notwithstanding the manifestations or expressions of suffering. The progress of the disease, as regards its dangerous effects, may thus be ascertained from time to time, and the fact of an actual improvement may be established more positively by an increased development of the vesicular murmur than by an apparent relief from the labor and distress attending respiration. In acute or dangerous affections, then, of the larynx, viz., acute laryngitis, croup, and œdema of the glottis, vastly more importance belongs to auscultation of the chest than of the larynx itself; and, in fact, the predictions of the physician, his hopes and fears, as well as the therapeutical measures which he employs, must be influenced in no small measure by the pulmonary signs.

Exploration of the chest assists the auscultator in determining whether an obstruction seated in the larynx be due either exclusively or in part to spasm of the glottis, or whether it depends entirely on a diminution of the calibre from a physical cause, such as œdema, exudation of lymph, or submucous infiltration. In the former case, the diminution or suppression of the vesicular murmur will be intermittent or variable; in the latter, it will be more persisting and uniform. Thoracic auscultation thus affords valuable aid in making the differential diagnosis of spasm of the glottis from other and far more serious affections, with which there is some liability of its being confounded. Moreover, spasm of the glottis forms an important element in other affections of the larynx, viz., laryngitis, true croup, and perhaps œdema. The extent to which the symptoms of suffocation are due to this element, may be fairly estimated by the development of the vesicular murmur under the circumstances in which relaxation of spasm occurs; for example, directly after a fit of vomiting. It is important to determine how much of the obstruction arises from spasm; not only in order to form a correct opinion as to the immediate danger, but with a view to therapeutical measures. In proportion as spasm predominates, are the indications present for remedies addressed to this element of the affection.

Dr. Stokes has pointed out a method, available in certain cases, by which pressure on the trachea of an aneurism, or other tumor, may be distinguished from laryngeal obstruction. In the former case it frequently happens that the direction of the pressure is upon one of the bronchi, before extending to the trachea; and if exploration of the chest be practised while the effect is limited to the bronchus, the consequent diminution or suppression of the vesicular murmur will be confined to the corresponding side of the chest. Subsequently, when the tumor increases sufficiently to diminish the calibre of the trachea, the vesicular murmur is lessened or lost on both sides. On the other hand, an obstruction seated in the larynx or in the trachea, will, from the first, affect equally the vesicular murmur on the two sides. Diminution or suppression of the vesicular murmur, then, first on one side, and afterwards extending to the other, provided pulmonary disease and the presence of a foreign body in the air-passages are excluded, indicates an aneurismal or other tumor, originating below the bifurcation, and extending gradually upward.

To recapitulate the several points of view in which an examination of the chest is useful, in the investigation of diseases affecting the trachea and larynx, it may prevent the error of attributing to a morbid condition of the windpipe, phenomena belonging to a pulmonary affection; it enables the physician to determine whether, or not, a laryngo-tracheal affection, *e. g.* croup, is complicated with a disease of the lungs, which will influence the prognosis and treatment; it furnishes evidence, or otherwise, of the coexistence of pulmonary tuberculosis with chronic laryngitis, and, by its negative results, may warrant the conclusion that the laryngeal affection is syphilitic; it furnishes the most reliable index of the amount of obstruction incident to the various forms of disease which diminish the calibre of the laryngo-tracheal tube, and it affords evidence that the deficiency of respiration proceeds from an obstruction in the tube, and not from a morbid condition of the pulmonary organs; it is a means of ascertaining whether an obstruction be due to spasm, and in cases of affections which involve a spasmodic element, of estimating the relative importance attributable to this element; and it supplies a method of distinguishing, in some cases, an aneurism or other intra-thoracic tumor, extending upward and making pressure on the trachea, from an obstruction seated in the larynx.

FOREIGN BODIES IN THE AIR-PASSAGES.

Foreign bodies occasionally slip from the pharynx into the orifice of the larynx. This accident is not very infrequent, occurring oftener in children than in adults. The bodies which have been known thus to become lodged in the windpipe, form a heterogeneous, motley collection—morsels of food, coins, grains of corn, seeds of various kinds, nuts, teeth, bullets, nails, etc. etc. Their size is often greatly disproportionate to the aperture at the glottis as observed in the dead subject, so that it has been difficult to account for the manner in which they gain entrance into the air-passages. This difficulty is removed by our present knowledge of the respiratory movements of the glottis. It has been fully demonstrated that dilatation and contraction of the space at the glottis occur in regular alternation during the respiratory acts, the first in inspiration and the second in expiration. When dilated with the act of inspiration, the size of the *rima glottidis* is nearly double that which it has in a state of rest.[1] Now it is in the act of inspiration, at a moment when the epiglottis fails to protect the laryngeal opening, that the foreign body is drawn into the air-tube instead of passing down the œsophagus. The approximation of the vocal chords with the consequent contraction of the outlet in the expiratory act, and still more in the act of coughing, constitutes an obstacle to the expulsion of the foreign body after it gains admission into the windpipe, and hence, in a large proportion of cases, a surgical operation becomes necessary to effect its removal.

The presence of a foreign body in the air-passages gives rise to serious effects, according to its situation, size, form, and character. More or less disturbance of respiration, and disease of the air-tube or lungs, almost inevitably follow. Frequently it occasions great obstruction to the passage of air, and not infrequently, unless speedy relief be obtained, it proves fatal by inducing asphyxia. The reader is referred to the valuable monograph by Prof. Gross for a digest and analysis of nearly all the cases that are to be found in the annals of medicine, in addition to those occurring under his own observation and communicated to him by his professional friends, together with deductions pertaining to the effects, symptoms, diagnosis, and treatment of this accident.[2]

Physical exploration furnishes frequently important information in cases of foreign bodies in the air-passages. 1. It assists in determining the fact of the presence of a foreign body, in some instances where it is a matter of question whether the symptoms are due to this cause or to a morbid condition. Cases have been reported in which patients with a foreign body in the windpipe have been treated for croup, ordinary laryngitis, and spasm of the glottis; and, on the other hand, in cases of these affections the presence of a foreign body is sometimes suspected. The importance, in a practical point of view, of settling this question is sufficiently obvious. In the former instance, there is great danger that life will be lost for the want of proper surgical interference; in the latter instance, a severe and dangerous operation may be needlessly performed, and other inappropriate measures of treatment resorted to. 2. It indicates the situation of the foreign body, whether in the larynx, trachea, or one of the bronchi. A foreign body may be lodged in each of these situations, and the relative proportion of instances in which it is found in each, is a point of importance with reference to the diagnosis. Of 21 cases proving fatal without a surgical operation, which were analyzed by Prof. Gross,[1] in 11 the foreign body was found in the right bronchus; in 4 within the larynx; in 3 within the trachea; and in 1 partly within the larynx and in part within the trachea. In no instance was it found in the left bronchus; but examinations made during life show that it does occasionally become fixed in that situation. The fact that in the vast majority of instances it falls into the right rather than the left bronchus, is to be borne in mind. The anatomical reasons for this fact, which are fully presented by Prof. Gross, have been already mentioned.[2] 3. The physical signs show the changes in the situation of the foreign body which are liable to occur. Prof. Gross states that in several instances falling under his own observation a change of place occurred, and in one case it was transferred from the right to the left bronchus. The same fact has been observed by others. The movableness of the body may also be ascertained by physical exploration; and this is an important point with reference to the probability of its being removed by a surgical operation. It has been known to become permanently fixed and encysted at some point in the air-passages. 4. The effect produced on the respiratory function, as determined by auscultation, authorizes an opinion as to the size of the foreign body, or, at all events, it shows the amount of obstruction which it produces, and the consequent immediate danger.

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[1] Vide Introduction, page 52.

[2] A Practical Treatise on Foreign Bodies in the Air-passages, by S. D. Gross, M.D, Professor of Surgery in the University of Louisville, etc. 1854.

Physical exploration in cases of foreign bodies, as in diseases affecting the trachea and larynx, may be said to have a direct and an indirect application. Using these terms in the same sense as heretofore, in its direct application it furnishes certain signs emanating from the windpipe itself; indirectly, it ascertains the phenomena which represent the effects produced on the lungs. Here, also, as in diseases affecting the trachea and larynx, the information obtained by an examination of the chest is often much more important than that derived from direct exploration of the windpipe. Proceeding to notice the physical signs, we will consider them in the order just mentioned, but without a formal division.

Percussion over the trachea or larynx is of little or no avail, but, in addition to auscultation, palpation is sometimes resorted to with advantage. Mainly, however, auscultation is to be relied upon, so far as physical exploration, in its direct application, is concerned. In auscultating both the windpipe and the chest, much difficulty will be likely to be experienced, in children, from their resistance, and the restlessness occasioned by their distress. Prof. Gross suggests, that to secure a satisfactory exploration, chloroform may with propriety be employed. The objections to this measure, if there are any, are yet to be ascertained by experience.

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[1] Op. cit. p. 49.

[2] Introduction, p. 48.

A dry rale may be produced at the point of lodgment of the foreign body, which may present either the sonorous or sibilant character. This sign was observed in several of the cases analyzed by Prof. Gross. The sound is described by different observers as *whizzing*, *whistling*, *cooing*, *whiffing*, *puffing*, and *snoring*. These terms, with the exception of the last, denote a high-pitched or sibilant rale. Diversities in the audible characters are unimportant. The intensity, pitch, or quality of the sound give to it no special significance. The practical importance of the rale consists, first, in the fact of its existence, and, second, in its being either limited to a particular part of the windpipe, or the maximum of its intensity being found at a certain point. The situation of the foreign body, it may be presumed, corresponds to the part where the rale is heard, or where it is most intense, especially if other signs, to be presently referred to, are in accordance with this conclusion. Thus, the rale may be observed only over the larynx, or if it be sufficiently loud to be propagated downward, it may be decidedly more intense over the larynx. The same may be true of the trachea; but in the vast majority of instances, if the foreign body be not detained in the ventricle of the larynx, it becomes lodged in one of the bronchi, and almost invariably in the right bronchus. A rale may then be heard near the sterno-clavicular junction on one side, or more marked in that situation on one side than on the other, indicating the bronchus in which it is situated. A curious phenomena was observed in a case reported by Prof. Macnamara, of Dublin.[1] A boy while occupied in whistling through a plum stone, perforated on each side, and the kernel removed, by a strong inspiration drew the stone into the larynx, where it became fixed transversely, without occasioning much inconvenience for several days. During this period the passage of the air through the perforation produced a sound as when the stone was placed across phenomena are made to supply positive proof with reference to the points just mentioned, by a simple process of reasoning. If a foreign body be lodged within the larynx or trachea, in proportion as it presents an obstacle to the passage of air, the vesicular murmur will be rendered feeble, or it may be suppressed; and assuming that there exists no affection of the lungs, the percussion-sound not only remains undiminished, but it may even be increased. Under these circumstances, the diminution or suppression of the vesicular murmur, co-existing with a clear resonance on percussion, will be found equally on both sides of the chest. Now, if it be known that a foreign body is contained somewhere within the air-passages, the combination of signs just stated, viz., the vesicular murmur diminished or suppressed equally on both sides, and a clear percussion-sound, indicates with positiveness that it is situated above the bifurcation, either within the trachea or larynx. But we will suppose that the presence of a foreign body is not known, and the question is as to the diagnosis, being assured that the lungs themselves are free from disease, and assuming that there has suddenly occurred marked diminution or suppression of the vesicular murmur, the inference is positive that either there is a foreign body in the windpipe, or that there exists some disease of the laryngo-tracheal tube which involves obstruction, such as acute laryngitis, *œdema glottidis*, spasm of the glottis, or croup. We have then only to decide from the history and symptoms that none of these affections are present, in order to reach, by way of exclusion, the fact of the existence of a foreign body. The differential diagnosis of a foreign body in the larynx or trachea from the different diseases seated in the windpipe, is to be based on the vital phenomena and pathological laws which characterize respectively these diseases. To consider the distinctive points would render it necessary to treat of their diagnostic features. It must suffice to say that, in discriminating between them and the presence of a foreign body, *they* are to be excluded, and the characteristics derived from symptoms and pathological laws which belong to each, are, in general, sufficiently constant and striking to constitute, when present, evidence of its existence, and, conversely, when absent, to warrant its exclusion. In one of the affections named, viz., *œdema glottidis*, the touch is often, if not generally, available as a means of diagnosis.

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[1] Gross on Foreign Bodies, p. 110; Stokes on the Chest, p. 253.

But in a large majority of instances, the foreign body does not remain in the larynx or trachea. It becomes lodged in one of the bronchi, generally the right bronchus. In this situation, according abnormally feeble or suppressed. If the body be easily displaced, and hence thrown upward from time to time, the physical evidence of obstruction of the bronchus will be intermittent; and if the body occasionally be transferred to the other bronchus, as has been repeatedly observed, the two sides will be found to present the characteristic combination of signs in alternation. Under these circumstances nothing could be added to render the diagnostic proof more positive. On this point Dr. Stokes remarks: "There is not in the whole range of stethoscopy more striking phenomena than the sudden rush of air into the lung, on the foreign body passing into the windpipe, or the equally sudden disappearance of all sound of expansion, natural and morbid, when the bronchus becomes again obstructed." The effect is, of course, more striking when the foreign body produces sufficient closure of the tube to arrest all respiratory sound, but the evidence is equally clear when there is obstruction enough to cause a notable diminution in intensity of the vesicular murmur.

It is obvious on comparing the phenomena furnished by an examination of the chest in cases in which the foreign body is seated in the larynx or trachea, with those which indicate its situation to be in the bronchus, that the diagnostic evidence in the latter is more striking and positive. In connection with this fact it is to be borne in mind that of a given number of cases, in vastly the larger proportion the foreign body falls into the right bronchus.

In the diagnosis of foreign bodies in the air-passages, not only are the physical signs to be associated with the symptoms, but in many if not most instances, as regards their relative rank, they are subordinate to the latter. In treating of this subject, however, as of the diseases affecting the trachea and larynx, my purpose was to consider it only in its relations to the principles and practice of physical exploration.

SUMMARY OF THE PHYSICAL SIGNS OF FOREIGN BODIES IN THE AIR-PASSAGES.

A sibilant or sonorous rale, either limited to the larynx, trachea, or bronchus, or having its maximum of intensity over one of these portions of the air-passages, and in some instances changing its place from one portion to another. After a time a mucous rale in either of the same situations; occasionally a valvular or flapping the lips, and the boy for some hours went about pleased with this novel and convenient method of whistling. The stone was localized by means of this sound, and an operation performed. The transference of a rale from one part to another, warrants a suspicion of a change of place of the foreign body; but this point, as will be seen presently, is ascertained more positively by an examination of the chest. If the foreign body be lodged in one of the ventricles of the larynx, it is not improbable that the presence of a rale on one side and not on the other, or a greater intensity of the sound on one side, may indicate in which of the ventricles it is situated.

When the foreign body remains in a certain position for some time, it produces local irritation, inflammation, or even ulceration of the mucous membrane. A moist or mucous rale may then become developed; and the same inferences are to be drawn from its being limited to one part, or from the maximum of intensity being localized, as in the case of a dry or vibrating rale. If the foreign body be lodged in one of the bronchi, inflammation is apt to extend to the bronchial subdivisions, giving rise to bronchial rales, either dry or moist, or both combined, over the chest, to a greater or less extent, on the corresponding side.

A flapping or valvular sound on auscultating the trachea and larynx, has been observed in some instances, due to the movements of the foreign body to and fro in the tube, by the current of air in the respiratory acts. The shock occasioned by the impulsion of the substance against the vocal chords in acts of coughing has also been found to be distinctly appreciable by the touch. And it is in such a case that palpation may prove a valuable method of exploration. In a case reported by the late Mr. Bransby B. Cooper, this tactile sign was so well marked in a boy who had inhaled a pebble into the windpipe, that the presence of the foreign body was predicated mainly upon it, the symptomatic phenomena being slight, and an operation successfully resorted to.[1] It is of course only in certain cases that this sign is available; but when present, it is highly significant of a hard, movable substance, like a pebble or shot, within the trachea.

An examination of the chest often affords evidence of the presence of a foreign body, and of its situation, more definite and reliable than the signs obtained by direct exploration of the windpipe. As already remarked, the results of the former of these two applications of physical exploration is much the more important. The pulmonary phenomena are made to supply positive proof with reference to the points just mentioned, by a simple process of reasoning. If a foreign body be lodged within the larynx or trachea, in proportion as it presents an obstacle to the passage of air, the vesicular murmur will be rendered feeble, or it may be suppressed; and assuming that there exists no affection of the lungs, the percussion-sound not only remains undiminished, but it may even be increased. Under these circumstances, the diminution or suppression of the vesicular murmur, coexisting with a clear resonance on percussion, will be found equally on both sides of the chest. Now, if it be known that a foreign body is contained somewhere within the air-passages, the combination of signs just stated, viz., the vesicular murmur diminished or suppressed equally on both sides, and a clear percussion-sound, indicates with positiveness that it is situated above the bifurcation, either within the trachea or larynx. But we will suppose that the presence of a foreign body is not known, and the question is as to the diagnosis, being assured that the lungs themselves are free from disease, and assuming that there has suddenly occurred marked diminution or suppression of the vesicular murmur, the inference is positive that either there is a foreign body in the windpipe, or that there exists some disease of the laryngo-tracheal tube which involves obstruction, such as acute laryngitis, *œdema glottidis*, spasm of the glottis, or croup. We have then only to decide from the history and symptoms that none of these affections are present, in order to reach, by way of exclusion, the fact of the existence of a foreign body. The differential diagnosis of a foreign body in the larynx or trachea from the different diseases seated in the windpipe, is to be based on the vital phenomena and pathological laws which characterize respectively these diseases. To consider the distinctive points would render it necessary to treat of their diagnostic features. It must suffice to say that, in discriminating between them and the presence of a foreign body, *they* are to be excluded, and the characteristics derived from symptoms and pathological laws which belong to each, are, in general, sufficiently constant and striking to constitute, when present, evidence of its existence, and, conversely, when absent, to warrant its exclusion. In one of the affections named, viz., *œdema glottidis*, the touch is often, if not generally, available as a means of diagnosis.

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[1] Gross on Foreign Bodies, etc. p. 111.

But in a large majority of instances, the foreign body does not remain in the larynx or trachea. It becomes lodged in one of the bronchi, generally the right bronchus. In this situation, according to its size and form, it produces either more or less obstruction, or complete occlusion of the bronchial tube. In proportion to the amount of obstruction, the vesicular murmur on the corresponding side will be diminished, and if there be occlusion, the murmur will be suppressed. If the lung be free from disease, the percussion-resonance will continue unaffected, unless the occlusion lead to more or less collapse of the lung. The latter effect, it is stated, may follow, and then there will be dulness in proportion as the volume of the lung is diminished, together with contraction and lessened mobility of the affected side.[1] This, however, is probably only an occasional result. The respiratory function of the lung on the opposite side will be increased, giving rise to a vesicular murmur, exaggerated in proportion as the function of its fellow is compromised. Here, then, we have an assemblage of pulmonary signs which point with certainty to the situation of the foreign body, assuming its presence in the air-passages to be known. A vibrating rale, heard exclusively, or with its maximum of intensity, over the bronchus, is a confirmatory physical sign. The same may be said of a mucous rale, in like manner circumscribed or diffused to a greater or less extent over the affected side.

Even if the presence of a foreign body somewhere in the air-passages be not known, the combination of physical signs just mentioned is almost proof positive of its existence, provided it be ascertained that they have been suddenly developed. As remarked by Stokes, there are but three affections capable of producing a similar assemblage of signs, viz., pressure on a bronchus by an aneurism or some other tumor; obstruction of the tube by hypertrophy of the mucous membrane, and its occlusion by an accumulation of viscid mucus. The symptoms and the previous history will rarely, if ever, leave much room for doubt, when it is a problem of diagnosis to decide between the presence of a foreign body in the bronchus, or the existence of one of these three morbid conditions.

Evidence still more demonstrative of the presence of a foreign body is afforded when it is found to shift its place, being removed from its situation in the bronchus by an act of coughing, and carried upward into the trachea, or perhaps transferred to the bronchial tube on the opposite side. Its dislodgment from the bronchus is immediately followed by the reappearance or the normal development of the vesicular murmur on the side where it had been found to be abnormally feeble or suppressed. If the body be easily displaced, and hence thrown upward from time to time, the physical evidence of obstruction of the bronchus will be intermittent; and if the body occasionally be transferred to the other bronchus, as has been repeatedly observed, the two sides will be found to present the characteristic combination of signs in alternation. Under these circumstances nothing could be added to render the diagnostic proof more positive. On this point Dr. Stokes remarks: "There is not in the whole range of stethoscopy more striking phenomena than the sudden rush of air into the lung, on the foreign body passing into the windpipe, or the equally sudden disappearance of all sound of expansion, natural and morbid, when the bronchus becomes again obstructed." The effect is, of course, more striking when the foreign body produces sufficient closure of the tube to arrest all respiratory sound, but the evidence is equally clear when there is obstruction enough to cause a notable diminution in intensity of the vesicular murmur.

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[1] Vide Gross on Foreign Bodies, p. 107.

It is obvious on comparing the phenomena furnished by an examination of the chest in cases in which the foreign body is seated in the larynx or trachea, with those which indicate its situation to be in the bronchus, that the diagnostic evidence in the latter is more striking and positive. In connection with this fact it is to be borne in mind that of a given number of cases, in vastly the larger proportion the foreign body falls into the right bronchus.

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A sibilant or sonorous rale, either limited to the larynx, trachea, or bronchus, or having its maximum of intensity over one of these portions of the air-passages, and in some instances changing its place from one portion to another. After a time a mucous rale in either of the same situations; occasionally a valvular or flapping sound. Motion of the foreign body sometimes perceived during acts of coughing by palpation.

Feebleness or suppression of the vesicular murmur equally on both sides, if the foreign body be situated within the larynx or trachea; the percussion-resonance remaining clear. If the foreign body be situated in a bronchus, the vesicular murmur on the corresponding side enfeebled or suspended, the percussion-resonance remaining clear, except collapse of the lung be induced. Feebleness or suppression of the murmur sometimes suddenly giving place to a well-evolved and normal respiratory sound, after an act of coughing, which dislodges the foreign body, and carries it upward into the trachea. Occasionally feebleness or suppression of the vesicular murmur transferred from one side to the other, indicating a removal of the foreign body from the bronchus of one side to that of the other side. Exaggerated vesicular respiration on the side opposite to that on which the murmur is found to be diminished or suppressed. Dry and moist bronchial rales, after a time, more or less diffused over the side corresponding to the bronchus in which the foreign body is lodged.

APPENDIX.

ON THE PITCH OF THE WHISPERING SOUFFLE OVER PULMONARY EXCAVATIONS.

In the foregoing pages, I have repeatedly referred to the souffle accompanying the act of whispering, as a sign of pulmonary condensation, especially from inflammatory, tuberculous, or other solidifying deposit. Since the chapter on Tuberculosis was written, my attention has been directed to the whispering souffle over excavations in that affection. In several instances I have found within a circumscribed space where other cavernous signs were present, a souffle more or less intense and *low in pitch*, contrasting in this particular strongly with the normal bronchial souffle, as well as with that significant of solidification, the latter being heard around the circumscribed space. For example, in a case at this moment under observation, the cavernous respiration exists at the summit of the chest on both sides. Surrounding the site of the cavity on either side the whispering souffle is acute or high, and within the area to which the cavernous respiration is limited (a space not more than an inch in diameter), the souffle becomes abruptly and notably low in pitch—the contrast, in fact, being more marked than between the cavernous and the surrounding bronchial respiration. A low-pitched cavernous souffle would be rationally anticipated; for the sound, as has been more than once remarked, is none other than that incident to a forcible expiration; and the expiration being low in the cavernous as contrasted with the bronchial respiration, it might be presumed that a similar disparity would be apparent in the act of whispering. This process of reasoning, however, never occurred to me till the disparity had been noticed. If the fact of this disparity be found to hold good after repeated observations, a new and an important cavernous sign is acquired, viz., a low-pitched whispering souffle. It is not, however, to be expected that this sign will always be available when cavities exist. For the same reason that the bronchial respiration may predominate, and mask the cavernous, the bronchial souffle may continue to be heard, notwithstanding the existence of an excavation. It is also probable that, as the bronchial and cavernous respiration are sometimes commingled, forming what I have called the broncho-cavernous respiration, so the bronchial and cavernous souffle may be combined in different cases in varying proportions.

I have felt the need of a term to designate the souffle incident to solidification. *Whispering bronchophony* would be appropriate, especially as we have already the term whispering pectoriloquy. Adopting this title, and limiting it to the acute souffle emanating from the bronchial tubes and constituting the sign of solidification, another is wanted to distinguish the sound produced in an excavation. I can suggest no better term expressive of the latter than *cavernous whisper.* This simple name accords with the term cavernous respiration. Whispering pectoriloquy, according to my experience, is by no means reliable as a sign of excavation. I have observed it repeatedly over solidified lung. But from the results just given, it may be inferred that the pitch of the vocal sound accompanying the transmitted speech, will furnish a test to determine whether the pectoriloquy be or be not cavernous in its source.

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